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X-RAY EQUIPMENT SURVEY IN POLK COUNTY, FLORIDA, SEPTEMBER 1961-AUGUST 1963

Edgar P. Seagle

Florida State Board of Health
Bartow, Florida

September 1964

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ENVIRONMENTAL HEALTH SERIES

Radiological Health

X-RAY EQUIPMENT SURVEY IN POLK COUNTY, FLORIDA

September 1961 - August 1963

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

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THE AUTHOR

Mr. Seagle, Field Project Officer for the study, is Assistant Chief, Medical X-Ray Program, State Assistance Branch, Division of Radiological Health.

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ABSTRACT

A field study concerned with human patient exposure in x-ray diagnosis was conducted in Polk County, Fla. The study included physical surveys of 91.5 percent of diagnostic x-ray equipment in the county in use by all categories of practitioners of the healing arts. The methodology used is described in detail and discussed, along with the keeping of patient data records, measuring of attitudes towards keeping records, measuring of acceptance of recommendations, devising an improved means of communicating with the practitioner, limited measuring of radiation exposure reduction to the population, and transferring of findings to data processing cards. The report includes 35 tables of data, a series of 20 photographs depicting physical measurements, and copies of letters and forms used throughout the survey.

ACKNOWLEDGMENTS

Special acknowledgment is made of the valuable contributions and guidance given to this study by:

Russell I. Pierce, M.D., Chief
State Assistance Branch
Division of Radiological Health
Public Health Service

and

Edwin G. Williams, M.D., Director
Division of Radiological & Occupational Health
Florida State Board of Health

Their efforts and abilities contributed greatly to the successful completion of this study.

The author also wishes to express gratitude for a job well done to project staff members Edward W. Kelley, Health Physicist Technician, and Mrs. Betty G. Crews, Secretary.

Appreciation for their full cooperation and support to this endeavor is also extended to Dr. James F. Cason, Polk County Health Director; Mr. Burney B. Cowden, Chief Sanitary Engineer, Polk County Health Department; the Polk County Commissioners; and the professional associations in this locality, and to the staff of the Division of Radiological and Occupational Health of the Florida State Board of Health for their varied and helpful assistance. Finally, the author wishes to thank Dr. George Crocker and Mr. Leroy Cook of the Division of Radiological Health, Public Health Service, for helping develop a data processing program for the information collected.

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I. INTRODUCTION

Surveys of x-ray machines for safety factors have been made in varying degrees of depth for many years. Only in recent years, however, has strong emphasis been placed on the public health importance of these surveys, what they should include, and how they can be performed effectively and feasibly on a nationwide basis. What to do or look for in surveying an existing x-ray installation in a practitioner's office is no longer a problem. Satisfactory guides and means of measuring parameters that contribute to reduction of radiation are currently in use and are being improved with continued research. This study concentrated on the problems of reaching each office that used x-ray machines, devising the best method of getting recommended changes accomplished, and obtaining human-exposure factors for ultimate use in studies designed to assess more reliably the dose to the population. Studies are being conducted at Johns Hopkins University (1), Sloan-Kettering Institute (2), and Emory University (3) in which human-exposure field data of this type and collected in this manner could be used.

To conduct a study involving the various aspects of x-ray exposure requires an approach from many angles and through various avenues. This study included some survey procedures not too unlike those associated with studies in Los Angeles (4), the State of Oregon (5), New York City (6), Charlotte, N. C. (7), and other cities and counties. The major aspects of this study encompassed most of the multiple facets of a complete x-ray survey and evaluation program and, it is hoped, will add new knowledge to the field of survey techniques. These facets are described in the following objectives and discussed in more detail in the report. Each objective achieved contributes knowledge upon which may be based the development of programs to minimize unnecessary x-radiation exposure.

II. OBJECTIVES

This study was concerned with the following objectives:

1. To make a physical survey of as many human diagnostic x-ray units in one county as possible, on the basis of voluntary participation by the users. In this program, each practitioner whose installation was physically surveyed was asked to keep records of x-ray examinations for a 4-week period.

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2. To supply data on patients, as well as physical data from the units on which x-rays were made, for use in studies designed to assess more reliably the population's exposure from this source. In this connection, investigators at Johns Hopkins University (1) are developing tables that will permit estimates of gonadal or other tissue doses from a knowledge of diagnostic exposure parameters and personal characteristics. It is likely that the Johns Hopkins type of study can be used to translate the type of field data developed in this study into population dose estimates.

3. To measure attitudes of practitioners toward the keeping of x-ray patient records as determined by personal interviews.

4. To measure acceptance of recommendations through an intensive followup program.

5. To devise better means of communicating with the practitioner by actively soliciting and recording his advice.

6. To measure reduction in radiation exposure to the specific population in terms of corrections made and patients affected.

7. To transfer data to data processing cards.

The scope of the study has been limited to the diagnostic use of x-rays and confined to one county in Florida. The study of patient exposure was based on age, sex, and other population characteristics. Emphasis was placed on the application of one methodology for effecting exposure reduction, with exposure evaluation in terms of exposure factors.

This report summarizes the study and the methodology used, and provides information that can be used by other State and local health departments in designing and conducting programs to minimize unnecessary radiation incident to the practice of the healing arts. The study project had the cooperation and approval of the county commissioners, the local medical and dental societies, the local health department, and other professional and lay groups.

III. LOCATION AND STUDY POPULATION

The work described in this report was carried out in Polk County, Fla. (fig. 1), which has the following characteristics:

1. A substantial population (200,000) but no large population density,

2. Both industrial and agricultural components,

1962-63

Population	200,000
Characteristics	Agricultural & Industrial
Physicians (M.D.)	148
Osteopaths	5
Dentists	56
Podiatrists	4
Chiropractors	21
Hospitals	6
Total offices having x-ray installations	118
Total offices participating (91.5%)	108
Total x-ray units of all kinds of offices participating (Av. 1.6 per office)	167

Figure 1. Location and Pertinent Characteristics of Polk County, Fla.

3. Central location in the peninsular part of the state.

At the beginning of the study in 1962, Polk County had 6 hospitals, 148 physicians (M.D.), 5 osteopaths, 21 chiropractors, and 4 podiatrists, in addition to 49 dentists, who made up the categories of those using x-rays for human diagnostic purposes. In 1963 the numbers increased to 150 physicians (M.D.) and 56 dentists; the podiatrists remained at 4, and the hospitals at 6; while the osteopaths decreased to 3 and the chiropractors to 19. The actual numbers of these various disciplines asked to participate in the study, who would also fit into the time cycle of the study, appear on the map (fig. 1) and in tables 2-7 in the Main Study section. Table 1 gives a breakdown of Polk County by age, color, and sex, based on the 1960 census. At that time it ranked fifth in population in the state.

Other statistics about Polk County include:

Area	- 1,863 square miles - 1,191,040 acres - Second in area in State
Industry	- Produces 80 percent of the United States supply of phosphate
Agriculture	- First in production of citrus fruits

Following is a list of medical specialties in Polk County as of July 31, 1963:

Ophthalmology	- 6	Radiology	- 7
Eye, ear, nose & throat	- 3	Allergy	- 1
General practice	- 52	Anesthesiology	- 3
Gynecology & obstetrics	- 13	Dermatology	- 1
Internal medicine	- 18	Neurology	- 1
Orthopedics	- 3	Neurosurgery	- 2
Pediatrics	- 10	Pathology	- 2
Surgery	- 21	Proctology	- 1
Urology	- 4	Psychiatry	- 2

Total 150

Table 1.--Population Distribution, Polk County, Fla.

Age (years)	1960 Population							1950 Population total
	All classes			White		Nonwhite		
	Total	Male	Female	Male	Female	Male	Female	
All ages.....	195,139	97,271	97,868	78,839	80,168	18,432	17,700	123,997
Under 1.....	4,341	2,185	2,156	1,627	1,569	558	587	2,581
1.....	4,370	2,195	2,175	1,670	1,591	525	584	5,580
2.....	4,360	2,213	2,147	1,654	1,601	559	546	--
3.....	4,349	2,140	2,209	1,622	1,656	518	553	5,414
4.....	4,379	2,232	2,147	1,697	1,611	535	536	--
5.....	4,375	2,208	2,167	1,700	1,604	508	563	2,407
6.....	4,225	2,123	2,102	1,647	1,620	476	482	2,509
7.....	4,181	2,170	2,011	1,729	1,531	441	480	--
8.....	4,120	2,090	2,030	1,637	1,551	453	479	6,749
9.....	3,972	1,991	1,981	1,562	1,533	429	448	--
10.....	3,816	1,928	1,888	1,494	1,468	434	420	--
11.....	3,848	2,013	1,835	1,631	1,474	382	361	8,303
12.....	3,820	1,970	1,850	1,592	1,507	378	343	--
13.....	3,931	2,007	1,924	1,681	1,608	326	316	--
14.....	3,209	1,583	1,626	1,288	1,311	295	315	1,964
15.....	3,182	1,605	1,577	1,335	1,275	270	302	1,746
16.....	3,223	1,625	1,598	1,359	1,330	266	268	3,683
17.....	3,118	1,527	1,591	1,244	1,319	283	272	--
18.....	2,853	1,417	1,436	1,126	1,226	291	210	3,622
19.....	2,546	1,153	1,393	922	1,157	231	236	--
20.....	2,383	1,147	1,236	920	1,014	227	222	1,736
21 and over..	116,538	57,749	58,789	47,702	49,612	10,047	9,177	77,703
Under 5.....	21,799	10,965	10,834	8,270	8,028	2,695	2,806	13,575
5 to 9.....	20,873	10,582	10,291	8,275	7,839	2,307	2,452	11,665
10 to 14.....	18,624	9,501	9,123	7,686	7,368	1,815	1,755	10,267
15 to 19.....	14,922	7,327	7,595	5,986	6,307	1,341	1,288	9,051
20 to 24.....	11,823	5,835	5,988	4,593	4,866	1,242	1,122	9,825
25 to 29.....	11,722	5,812	5,910	4,515	4,737	1,297	1,173	9,530
30 to 34.....	12,613	6,236	6,377	4,982	5,204	1,254	1,173	9,280
35 to 39.....	12,748	6,373	6,375	5,186	5,336	1,187	1,039	9,516
40 to 44.....	12,212	6,204	6,008	5,154	4,993	1,050	1,015	8,341
45 to 49.....	11,728	5,916	5,812	4,856	4,780	1,060	1,032	7,422
50 to 54.....	10,177	5,076	5,101	4,120	4,301	956	800	5,926
55 to 59.....	8,807	4,327	4,480	3,537	3,813	790	667	5,148
60 to 64.....	7,284	3,390	3,894	2,947	3,463	443	431	4,418
65 to 69.....	7,493	3,649	3,844	3,257	3,462	392	382	5,051
70 to 74.....	5,837	2,969	2,868	2,658	2,568	311	300	2,823
75 to 79.....	3,618	1,745	1,873	1,566	1,719	179	154	2,703
80 to 84.....	1,819	889	930	827	874	62	56	--
85 and over..	1,040	475	565	424	510	51	55	456
Under 18 years	70,819	35,805	35,014	28,168	27,159	7,636	7,855	40,936
65 and over..	19,807	9,727	10,080	8,732	9,133	995	947	10,033
Median age...	29.1	28.8	29.3	30.1	30.9	24.3	22.4	29.0

Source: Department of Commerce, Bureau of the Census

IV. PRELIMINARY PLANNING

Planning for the study involved finding out the number of diagnostic units in the county and their location, and estimating the number of personnel and the time necessary to make initial and subsequent visits. Prior to this, cooperation was obtained from the various local professional societies, health department, and commissioners; and office space was located.

Personnel used in the study included:

1 physician (M.D.) as project director
1 sanitary engineer as field project officer
1 health physicist technician
1 stenographer

Staff members of the Division of Radiological and Occupational Health of the State Board of Health assisted as needed and as their other duties would permit.

V. METHODS

To gain support of the health department, a personal visit was made by the project director and the purposes and advantages of the study were fully explained. A mutual agreement that such a study would be valuable to the health of the population was reached, and the local health unit pledged its cooperation.

To obtain the sanction of professional societies, the presidents of the respective associations in the State were contacted to inform them that a research study was proposed, and to invite their comments and participation. Their general approval was received. A statewide committee of professionals in the healing arts and sciences was formed to provide advice and consultation. Attendance at the first planning session is shown in appendix 1.

To locate office space in the selected county, the local health department was called upon for help. No space was available in the health department building proper, so adequate space was rented from contract funds in another county-owned building. The rental rate was much lower than would normally be charged in the commercial market and the reduced rate was part of the county's contribution to the study. A close association was maintained with the local health office at all times.

To obtain lists of x-ray operators, the yellow pages of each telephone directory in the county and the roster of members of the local professional societies were used. In addition, the local health department staff was very helpful.

To gain entry into offices of x-ray operators, a letter (apps. 4, 6) was sent to each practitioner requesting his cooperation in the study and briefly explaining the record-keeping phase of the program. A slip was enclosed on which the practitioner could check one of the four categories:

____ Come by to check my x-ray unit.
____ Come by to further discuss this.
____ I will not be able to participate.
____ I have no x-ray equipment.

A self-addressed, stamped envelope was enclosed for his convenience. The practitioner signed his name, gave the installation address, and suggested a convenient day and time to call. (None checked the second item.) Obviously, this also served as a type of registration form for x-ray sources. Tables 2-7 in section VIII show breakdown of replies. If a reply was not received in 4 weeks a second letter (apps. 5, 7) was sent, stating that the survey was still underway and that in order to better evaluate the effectiveness of this program a reply from him was needed. Those replying positively were promptly surveyed and the record keeping started. Each office was called a day in advance to make sure the office personnel engaged in x-ray work would be present at the time of our visit. The series of photographs shown in section VII presents a step-by-step visualization of the medical physical survey.

To have records kept of x-ray examinations by the practitioners, we explained at the time of the initial visit the importance of gathering such data. A record book with 50 forms was left with the practitioner after a thorough explanation had been given as to the proper method of filling out the form. Appendix 10 shows the medical patient form and appendix 13 the dental patient form. A followup visit was made to the office each week to answer any questions that may have developed, to supply additional forms, and to see that a high quality of record keeping was maintained. The fact that a personal call was made added to the importance given to the record keeping. Each recorder was paid $15 when the records were satisfactorily completed. A thank-you letter was mailed with the check (app. 15).

To make a physical survey of the installation, the report form shown in appendix 9 was used for all medical-type x-ray units. All items asked for on the form were completed. A written description of the equipment used for the measurements is listed in appendix 8. The report form attached as appendix 12 was used for the dental physical survey, and appendix 14 shows the recommendation form mailed back to the practitioner. The same equipment listed in appendix 8 was equally applicable, with the addition of an 8-inch-square fluorescent screen for determination of beam size and a paper bag of rice for use as a phantom head.

To test the validity of these selected methods and provide a basis for further planning, a pilot study was arranged and carried out.

VI. PILOT STUDY

Using the methods described above, 5 x-ray installations having 14 x-ray units used in the practices of 34 physicians (M.D.) were contacted (app. 3). Every one of the physicians approached participated in this pilot study. These units were surveyed, including the accomplishment of radiation measurements, and records of subsequent x-ray examinations were kept for 4 weeks.

Results of the pilot study led to the following conclusions:

1. Records of x-ray examinations should be kept at least 4 weeks to obtain what the practitioner considered to be the typical caseload and variation of types of exposures. There was no objection by the practitioners to a 4-week period.
2. Attitudes toward obtaining past records ranged from poor to refusal.
3. Attitudes toward keeping subsequent records were good.
4. Attitudes toward the physical inspection of the x-ray unit ranged from good to excellent.
5. It was demonstrated that a three-man team was most suitable for the initial office call: One man to begin setting up for the physical measurements, the second to assist and record, and the third to go into detail with the practitioner on the record-keeping aspects of the survey. This discussion required thorough explanation and understanding. The physician needed assurance that the information he supplied would be held in confidence and that it was of importance in the research phase of this study. For subsequent office visits, one or two men were adequate.

With this information, plans were made for the main study which began with the remainder of the medical doctors and hospitals and eventually included the osteopaths, chiropractors, podiatrists, health department, and dentists. A flow chart showing the program used in the New York University Study (8) appears in appendix 2 for comparison with the Polk County study program.

VII. PHOTODOCUMENTATION

The series of photographs in this section portrays the step-by-step procedure of the physical survey and record keeping conducted in this study. The photographs show the x-ray survey team calling on a physician, making the measurements and observations asked for on the medical x-ray survey form, the instruments and techniques used, and finally the surveyor discussing x-ray patient data records with the physician and his technician. Aside from the record keeping aspects of this study, the survey team depicted here could well be a team in any State or local health department.

This series of black and white photographs with corresponding color slides is available on loan from the Public Health Service, Division of Radiological Health, Training Branch, Audiovisual Design Section, Rockville, Md. The Audiovisual Design Section initiated and financed the cost of the original photography. It was felt that photographs showing just what a survey team does after being admitted to a practitioner's office would be a valuable aid in visualizing the extent of measurements taken.

Figure 2. Survey team is introduced to physician and gives him brief description of measurements to be made and length of time survey will take.

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Figure 3. Equipment is set up in x-ray room while team discusses film badge monitoring with x-ray technician and physician.

Figure 4. Team records identification numbers while discussing gonadal shields and other protective devices.

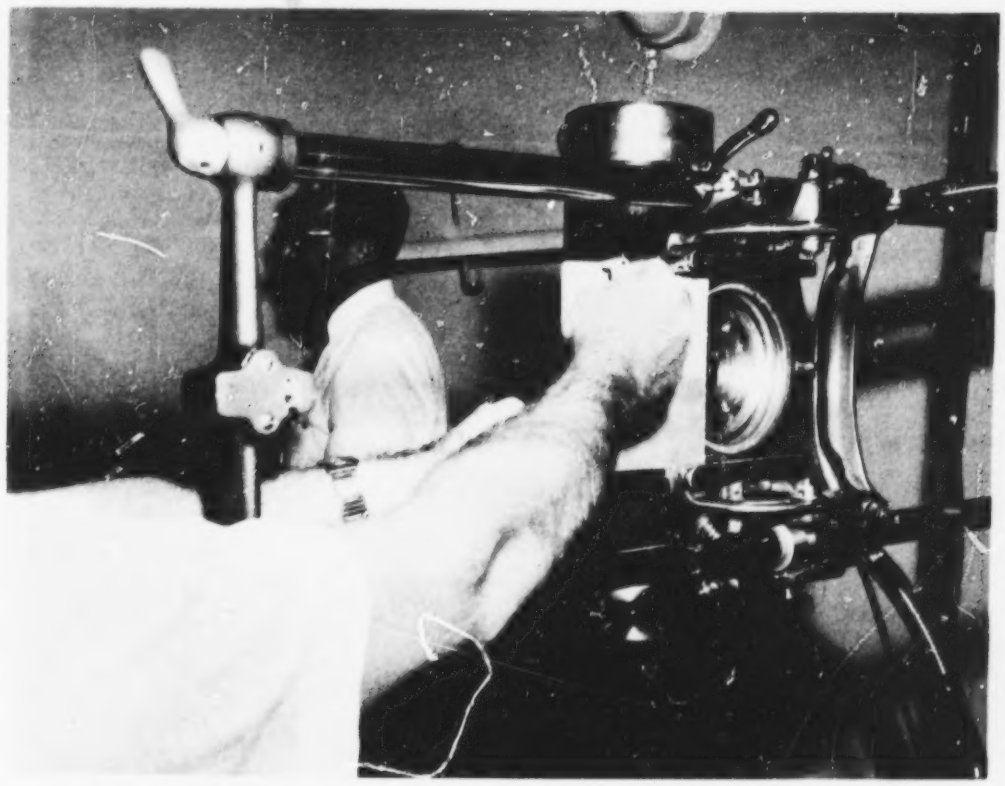

Figure 5. Added filtration is measured using slotted key.

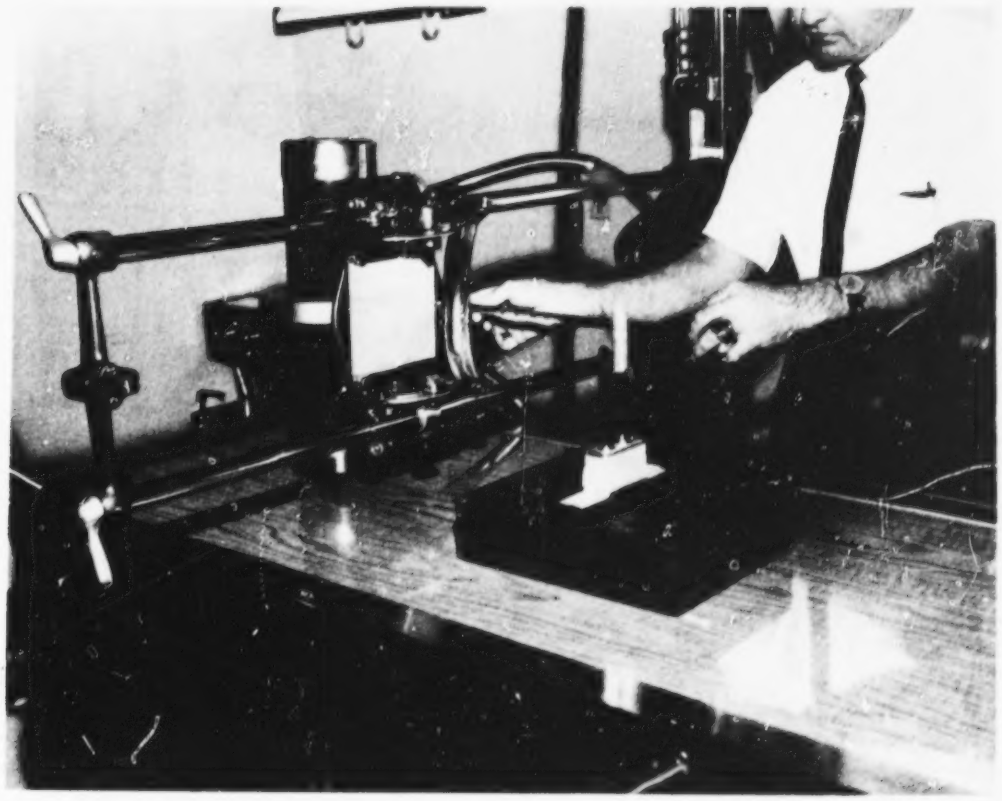

Figure 6. Total filtration is measured using cap-on - cap-off method.

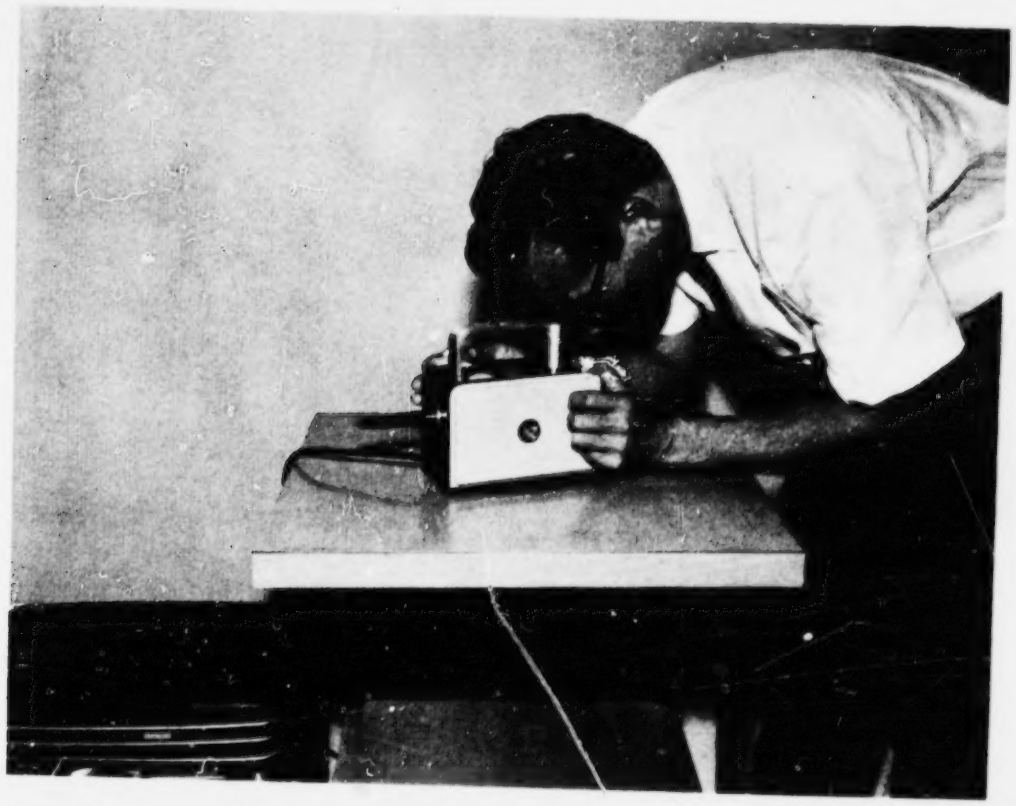

Figure 7. R-chamber is inserted into R-meter and chamber reading is recorded.

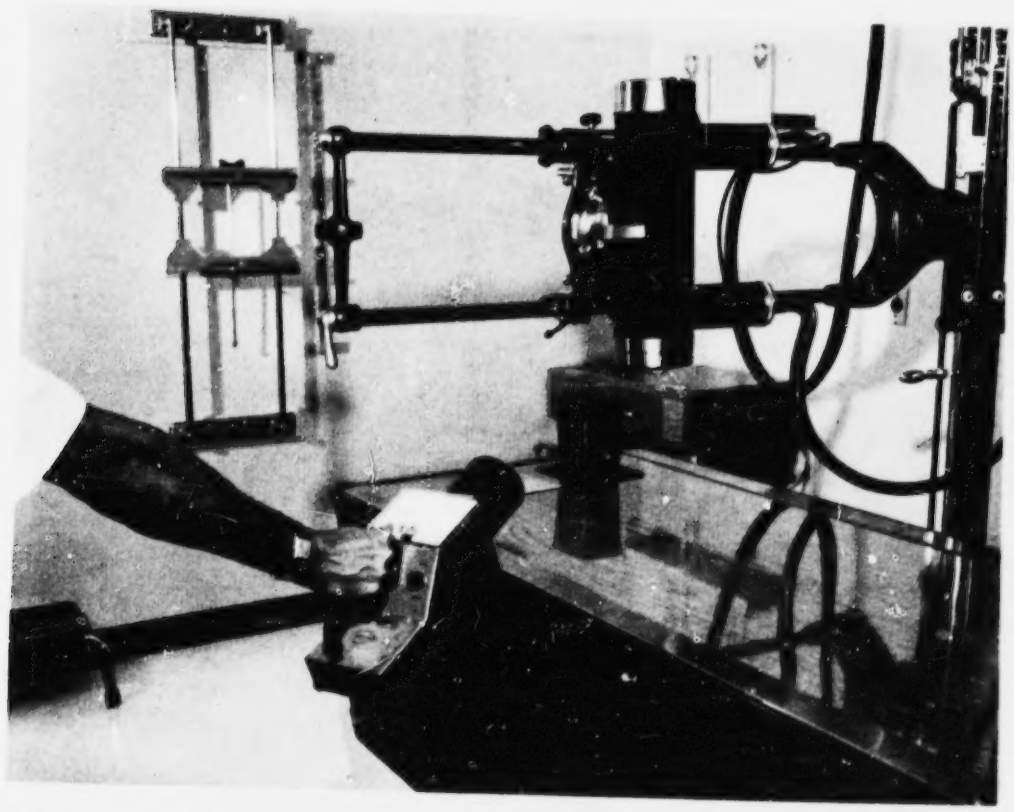

Figure 8. Leakage radiation around tube housing is measured at distance of 1 meter.

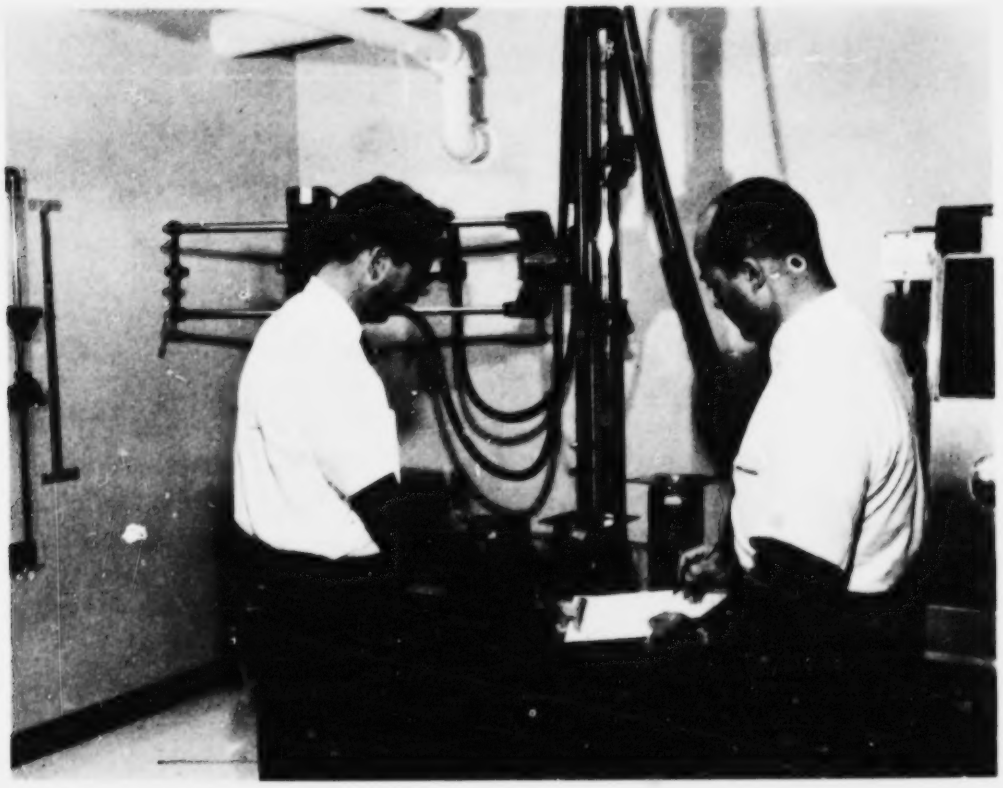

Figure 9. Radiographic cones are numbered for future identification.

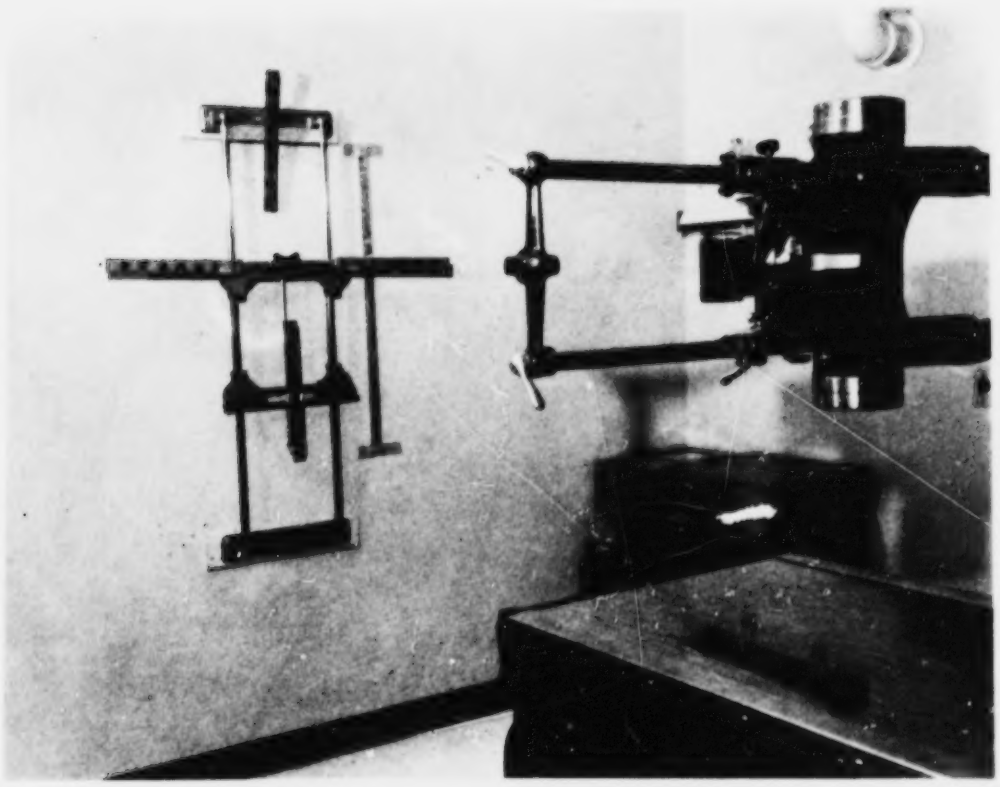

Figure 10. Fluorescent strips are used to determine beam dimension of each cone at the plane of the film.

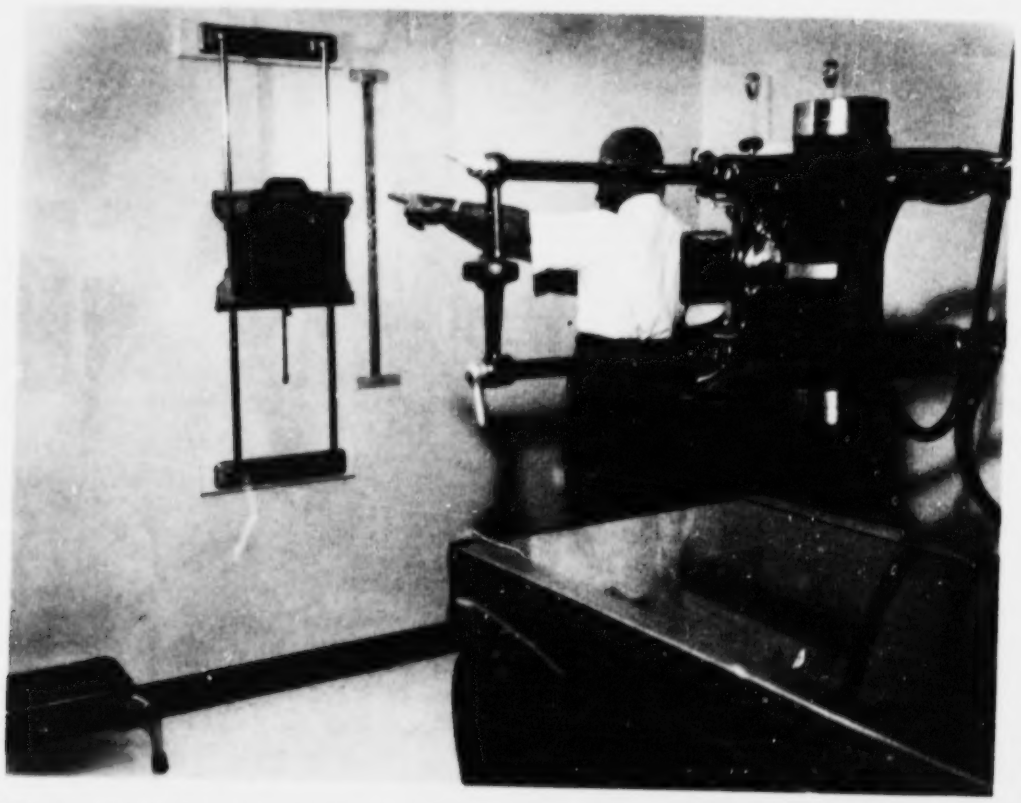

Figure 11. Linear ruled scale is used for proper alignment of x-ray beam with the plane of the film, and a wood-block phantom is positioned to simulate a patient during chest exposures.

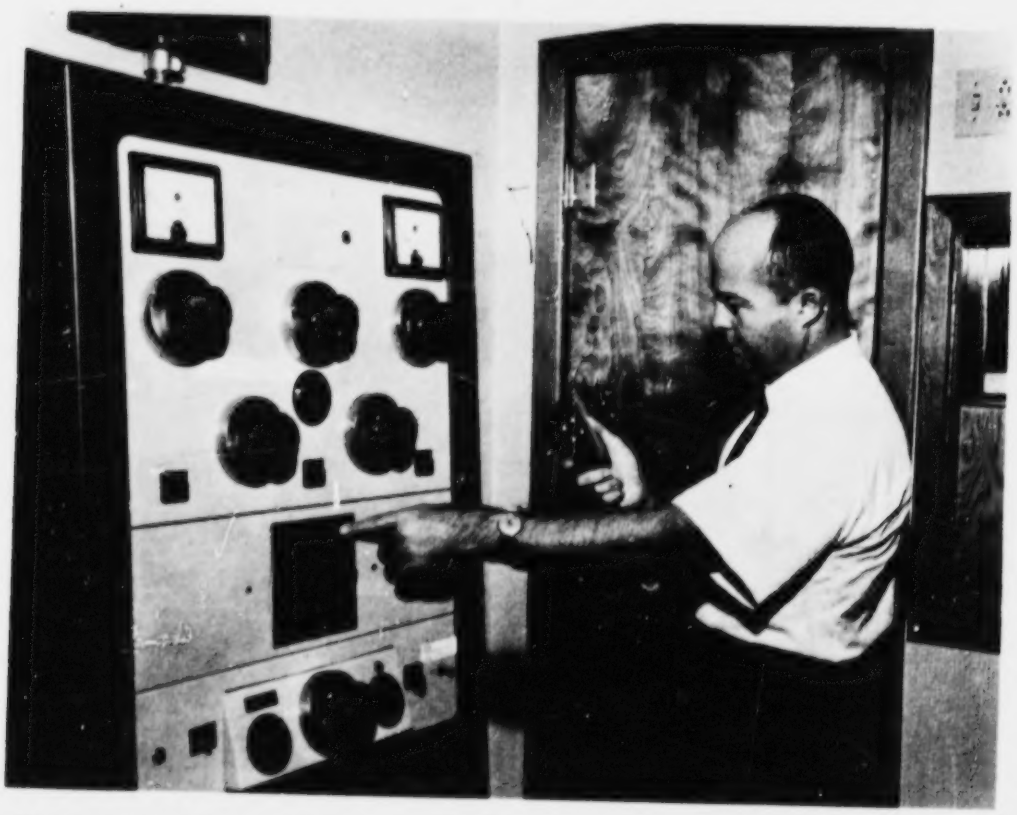

Figure 12. Observation reveals that timer is electronic; it terminates exposures and is a dead-man type switch.

Figure 13. Stray radiation is measured behind operator's protective barrier.

Figure 14. Team inspects lead apron, lead gloves, and red goggles used by fluoroscopist (note lead-backed chair but no bucky-slot cover and no leaded drapes around screen).

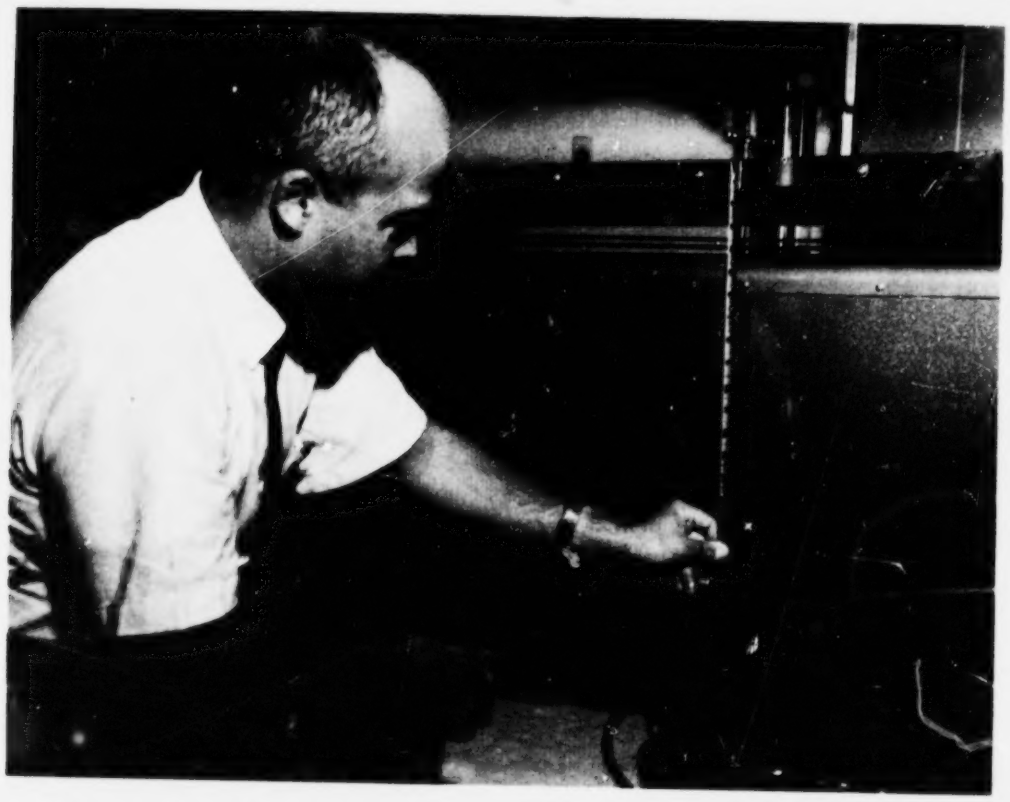

Figure 15. Distance from tube target to tabletop is measured.

Figure 16. Scatter radiation to x-ray technician is measured at his reported position during fluoroscopy, using a simulated patient.

Figure 17. Primary beam spillover around fluorescent screen is measured when shutters are wide open, and shutter controls are checked for proper function.

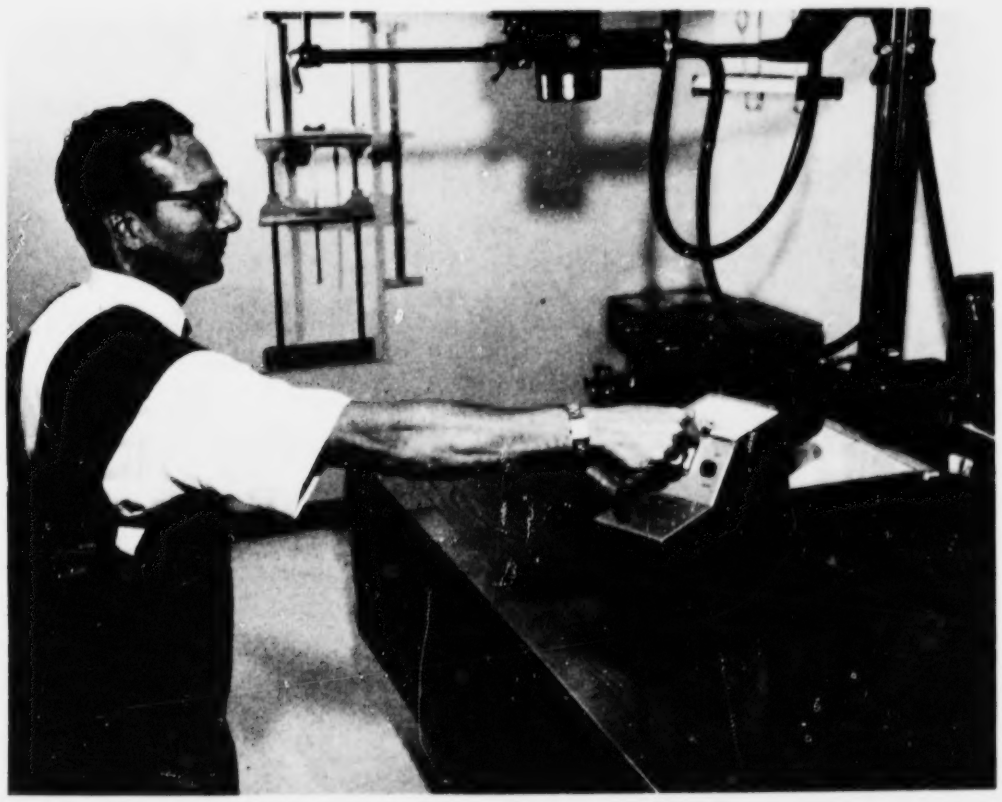

Figure 18. X-ray transmission through leaded glass over fluorescent screen is measured.

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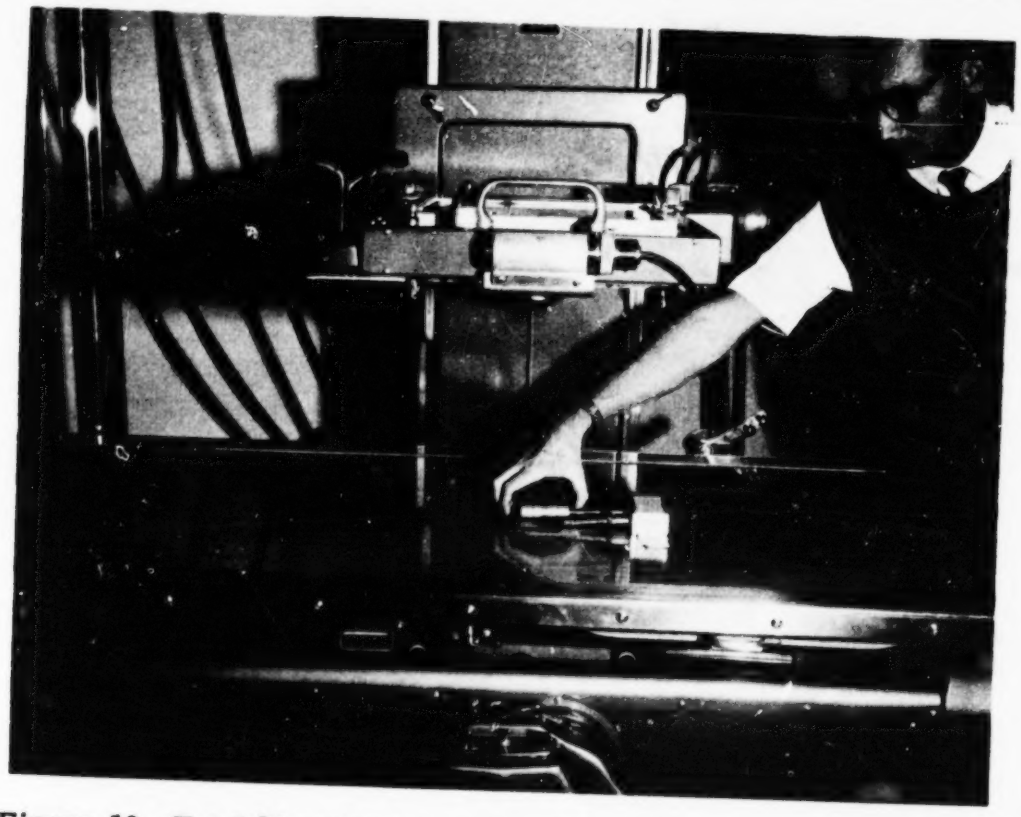

Figure 19. Total filtration is measured (using cap-on - cap-off procedure) and also tabletop dose rate.

Figure 20. Stray radiation is measured at secretary's desk in adjacent office while typical exposures are being made in x-ray room using simulated patient.

Figure 21. Summary of findings is presented to physician and x-ray technician, and physician is asked to keep a record of each x-ray patient for the next 4 weeks.

VIII. MAIN STUDY

The technique used to start the main study was the same as that for the pilot study. Accuracy of record keeping was enhanced by the fact that participation was voluntary and by the cooperative attitude of the practitioners and their assistants.

Procedure

The procedure used to carry out the main study involved essentially four steps:

1. Initial office visit: Physical survey of the x-ray installation was performed but no recommendations were made at this time. Record keeping was begun by the practitioner or technician on each patient x-rayed and continued for 4 weeks. A followup was made each week to check on completeness of records and to answer any questions. The record keeping form (app. 10) was adapted from the New York University Study (8).
2. Office visit at the end of 4 weeks: Final records were picked up and a visual and/or question and answer type survey was made at this time to determine whether any changes in the

x-ray unit or procedures had taken place. Our desire was to keep conditions constant for the 4-week record keeping period. Recommendations in the form of a written report were issued within a few days to supplement verbal ones.

3. Office visit at the end of 16 weeks: This call was made to ascertain whether or not corrections had been made. If they had (for example, by obtaining a new cone), new measurements were made to determine the reduction in beam diameter. If corrections recommended had not been made, efforts were directed toward finding out why not (app. 16). Tabulations of reasons given for not making recommended changes, and answers to other related questions, are shown in tables 19 and 20. If all corrections recommended had not been made by the time of this visit, it was announced that another visit would be made in a few months and the practitioner was encouraged to make the corrections before that time. Tabulations of the results of the first and second followup visits are broken down by category in tables 11-18.

4. Office visit at the end of 28 weeks: This final visit was made to ascertain the effects of our previous followup visit on the increase in number of recommended corrections completed, and was the last visit to any one office for purposes of this study.

The magnitude of the study can be better appreciated when one considers that, on an average, 6 separate visits were made to each office during the course of the study--for a total of approximately 650 visits.

Replies

Replies from the various categories of x-ray users are presented in the following tables:

Table 2. --Replies from Physicians (M. D.)

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	29	6	35	37.6
Have no x-ray equipment	48	1	49	52.7
Will not be able to participate	1	1	2	2.2
Total	78	8	86	92.5

Note: 93 letters were mailed to offices representing 148 physicians; replies are listed by office.

Table 3. --Replies from Osteopaths (D. O.)

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	1	1	2	40
Have no x-ray equipment	2	0	2	40
Will not be able to participate	0	0	0	0
Total	3	1	4	80

Note: 5 letters were mailed to 5 offices representing 5 osteopaths; replies are listed by offices.

Table 4. --Replies from Chiropractors (D. C.)

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	7	5	12	70.6
Have no x-ray equipment	1	0	1	5.9
Will not be able to participate	2	0	2	11.8
Total	10	5	15	88.3

Note: 17 letters was mailed to 17 offices representing 21 chiropractors; replies are listed by office.

Table 5. --Replies from Podiatrists (D. S. C.)

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	4	--	4	100
Have no x-ray equipment	0	--	0	0
Will not be able to participate	0	--	0	0
Total	4	0	4	100

Note: 4 letters were mailed to 4 offices representing 4 podiatrists; replies are listed by office.

Table 6. --Replies from Hospitals

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	6	--	6	100
Have no x-ray equipment	0	--	0	0
Will not be able to participate	0	--	0	0
Total	6	--	6	100

Note: 6 letters were sent to 6 hospitals.

Table 7. --Replies from Dentists (D. D. S.)

	To first letter	To second letter	Total number replies	Percent
Come by to check my x-ray unit	42	5	47	88.7
Have no x-ray equipment	0	0	0	0
Will not be able to participate	1	1	2	3.8
Total	43	6	49	92.5

Note: 53 letters were mailed to 53 offices representing 56 dentists; replies are listed by office.

Participation

The totals of offices using x-ray equipment and participating in the study are shown in table 8.

Table 8. --Participation of X-Ray Equipped Offices

Category	Number in county	Number contacted	Number of offices	X-ray offices	X-ray offices participating	Percent x-ray offices participating
Health Dept	1	1	9	2	2	100
Hospital	6	6	6	6	6	100
Podiatrist	4	4	4	4	4	100
Osteopath	5	5	5	2	2	100
Dentist	56	56	53	52	49	94.2
Chiropractor	21	21	17	15	13	86.7
Physician (M. D.)	148	148	93	37	32	86.5

Note: Totals of offices participating may differ slightly from the totals of positive replies shown in tables 2-8 because of additions or cancellations during the study cycle. This table reflects the actual numbers at the conclusion of the study.

Physical Survey Findings

A condensed summary of the physical survey findings is presented in tables 9 and 10. Explanations of the bases on which corrections were requested are given in footnotes at the end of the tables. Need for corrections was based on pertinent sections of the regulations of the Florida State Board of Health for the control of radiation hazards, which coincide for the most part with the recommendations of the National Committee on Radiation Protection and Measurements as published in Handbook 76 of the National Bureau of Standards (9). Only a few specific items such as beam dimension, filtration, and target-to-panel distance have been singled out. Recommendations for corrections (such as means of beam alignment, shielding, and dark adaptation) are grouped together under Other. A large number of tables on the physical survey could be prepared from the IBM cards, as explained in section X, but tables 9 and 10 were selected as a good summary.

Followup Survey

In this study, followup visits were made for a twofold purpose. The first was the simple task of finding out if any corrections had been made. The second was to determine if this followup visit would induce the practitioner to make more of the recommended changes, or at least some changes if he had previously made none. To encourage his cooperation, some further educational efforts were made at this time. The questions shown in appendix 16 were asked; the recommendations were thoroughly reviewed; and the surveyor again offered his services in any manner that would aid the practitioner.

After another 3-month interval the surveyor returned to measure the effects of his previous followup visit. Results showed that a followup program is essential in order to derive a high degree of benefit from an x-ray survey program. The cost of returning to the practitioner's office one more time is minimal compared to the outlay of funds for personnel, equipment, planning, and the many other details associated with making the initial physical survey. The results in this study showed an approximate threefold overall increase of offices making all corrections when a followup visit was made. This is a significant finding and one that should guide future surveys.

Table 9.--Summary of Physical Survey (M. D.)

Category	Instal-lations	Practitioner	Radiograph				Fluoroscope			
			No. of units	Needing correction			No. of units	Needing correction		
				Beam Di-mension [a]	Fil-tration [b]	Other		Target-to-panel distance [c]	Fil-tration [b]	Other
G. P.	18	33	16	13	12	10	8	2	7	6
Internal	4	9	3	3	2	3	2	1	1	2
Surgery	4	4	4	4	2	3	1	0	0	1
Urology	2	2	2	1	2	1	0	0	0	0
Radiology	2	2	4	2	1	0	3	0	1	1
Gyn. & Ob.	1	1	1	1	1	1	0	0	0	0
Orthopedic	1	2	1	1	1	1	1	0	1	1
Total	32	53	31	25	21	19	15	3	10	11

[a] Beam diameter over 24 in. for chest x-ray was criterion.
[b] Less than 2.5 mm. aluminum equivalent was criterion.
[c] Less than 12-in. distance was criterion.

Table 10. --Summary of Physical Survey (Other)

Category	Installations	Practitioner	Radiograph				Fluoroscope			
			No. of units	Needing correction			No. of units	Needing correction		
				Beam Dimension[a]	Filtration[b]	Other		Target-to-panel distance[c]	Filtration[b]	Other
Hospital	6	[d] 7	18	7	5	7	11	0	0	5
Health Dept.	2	1	2	2	1	1	0	0	0	0
Osteopath	2	2	2	2	0	1	1	0	0	0
Podiatrist	4	4	4	0	0	1	0	0	0	0
Chiropractor	13	16	13	4	1	2	1	0	0	1
Dentist	49	51	69	19	23	4	0	0	0	0
Total	76	81	108	34	30	16	13	0	0	6

[a] For hospital, health dept, osteopath, podiatrist, and chiropractor: beam diameter over 24 in. for chest x-ray was criterion. Where chiropractor made spinogram (14" x 36") but no chest alone this was not tabulated as needing correction. For dentist: beam diameter over 3 in. was criterion.

[b] For hospital, health dept., osteopath, podiatrist, and chiropractor: Less than 2.5 mm. was criterion. For dentist: less than 1.5 mm. for 70 kv. units and less than 2.5 mm. for 90 kv. units was criterion.

[c] Less than 12-in. distance was criterion.

[d] Radiologists

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The results are presented in tables 11 through 16 for the separate disciplines, and then in a combined table for practitioners and hospitals.

Table 11.--Results of Followup Visits to Physicians (M.D.)

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	32	30	2	4	8	16	2
Percent	100	94	6	[a] 13.3	[a] 26.7	[a] 53.3	[a] 6.7
				Second recheck			
Number	30	24	6	14	4	6	0
Percent	100	75	25	[b] 58.3	[b] 16.7	[b] 25	0
				Summary of first and second rechecks			
Number	32	30	2	18	4	6	2
Percent	100	94	6	[a] 60	[a] 13.3	[a] 20	[a] 6.7

[a] Based on 30 = 100% those needing corrections.

[b] Based on 24 = 100% those remaining needing corrections.

Note: Rechecks made at 3-mo. intervals.

Summary: No consultation beyond initial survey:

13.3% made all corrections.
40.0% made all or some corrections.

With further consultations:

60.0% made all corrections after a second visit to further discuss recommendations made.
73.3% made all or some corrections.

Conclusion: At least one followup visit to encourage needed corrections is necessary for a successful program.

Table 12.--Results of Followup Visits to Hospitals

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	6	5	1	1	2	2	0
Percent	100	83.3	16.7	[a] 20	[a] 40	[a] 40	0
				Second recheck			
Number	6	4	2	3	1	0	0
Percent	100	66.7	33.3	[b] 75	[b] 25	0	0
				Summary of first and second rechecks			
Number	6	5	1	4	1	0	0
Percent	100	83.3	16.7	[a] 80	[a] 20	0	0

[a] Based on 5 = 100% those needing corrections.
[b] Based on 4 = 100% those remaining needing corrections.

Note: Recheck made at 3-mo. intervals

Summary: No consultation beyond initial survey:

20% made all corrections.

60% made all or some corrections.

With further consultation:

80% made all corrections after a 2nd visit to further discuss recommendations made

100% made all or some corrections.

Conclusion: At least one followup visit to encourage making needed corrections is necessary for a successful program.

Table 13. --Results of Followup Visits to Osteopaths

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	2	2	0	1	0	1	0
Percent	100	100	0	[a] 50	0	[a] 50	0
				Second recheck			
Number	2	1	1	0	0	1	0
Percent	100	50	50	0	0	[b] 100	0
				Summary of first and second rechecks			
Number	2	2	0	1	0	1	0
Percent	100	100	0	[a] 50	0	[a] 50	0

[a] Based on 2 = 100% those needing corrections.
[b] Based on 1 = 100% remaining needing corrections

Note: Rechecks made at 3-mo. intervals.

Summary: No consultation beyond initial survey:

50% made all corrections.
50% made all or some corrections.

With further consultation:

No change

Conclusion: Sample is too small to be of general significance.

Table 14. --Results of Followup Visits to Chiropractors

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	13	7	6	3	0	4	0
Percent	100	53.9	46.1	[a] 42.9	[a] 0	[a] 57.1	0
				Second recheck			
Number	13	4	9	2	0	2	0
Percent	100	30.8	69.2	[b] 50	0	[b] 50	0
				Summary of first and second rechecks			
Number	13	7	6	5	0	2	0
Percent	100	53.9	46.1	[a] 71.4	0	28.6	0

[a] Based on 7 = 100% those needing corrections.
[b] Based on 4 = 100% those remaining needing corrections.
Note: Rechecks made at 3-mo. intervals.
Summary: No consultation beyond initial survey:
42.9% made all corrections
With further consultation:
71.4% made all corrections.
Conclusion: A followup visit to encourage making needed corrections is advantageous.

Table 15. --Results of Followup Visits to Podiatrists

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	4	1	3	1	0	0	0
Percent	100	25	75	[a] 100	0	0	0

[a] Based on 1=100% those needing corrections.
Note: 1st recheck made at 3-mo. interval.
2nd recheck not necessary.
Summary: No consultation beyond initial survey:
100% made all corrections.
Comment: The high percentage of installations (75%) needing no corrections probably accounts for the 100% correction with no further consultation since it was based on only one office making the necessary changes. However, the change recommended cost approximately $50; therefore it is more significant than if it had only been a $2 item.

Table 16.--Results of Followup Visits to Health Department

	Offices with x-ray installations			First recheck			
	Total	Corrections		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	2	2	0	2	0	0	0
Percent	100	100	0	[a] 100	0	0	0

[a] Based on 2=100% those needing correction.

Note: 1st recheck made at 3-mo. interval.
2nd recheck not necessary.

Summary: No consultation beyond initial survey:
100% made all corrections.

Comment: This is to be expected with the health department, particularly in this instance as the study was a joint effort of the local health department and the State health department.

Table 17.--Results of Followup Visits to All X-Ray Users Excluding Dentists

	Offices with x-ray installations			First recheck			
	Total	Correction		Corrections completed			Moved out of county
		Needed	Not needed	All	Some	None	
Number	59	47	12	12	10	23	2
Percent	100	79.7	20.3	[a] 25.5	[a] 21.3	[a] 48.9	4.3
				Second recheck			
Number	57	33	24	19	5	9	0
Percent	100	57.9	42.1	[b] 57.6	[b] 15.1	[b] 27.3	0
				Summary of first and second rechecks			
Number	59	47	12	31	5	9	2
Percent	100	79.7	20.3	[a] 65.9	[a] 10.6	[a] 19.2	[a] 4.3

[a] Based on 47=100% those needing corrections.
[b] Based on 33=100% those remaining needing corrections.

Note: Rechecks made at 3-mo. intervals.

Summary: No consultation beyond initial survey:
25.5% made all corrections.
46.8% made all or some corrections.
With further consultation:
65.9% made all corrections after a 2nd visit to further discuss recommendations made.
76.5% made all or some corrections.

Conclusion: At least one followup visit to encourage making needed corrections is necessary. (The increase in percentage of corrections made warrants the time and expense of a 2nd visit.)

Table 18. --Results of Followup Visits to Dentists

	Offices with x-ray installations			First recheck		
	Total	Corrections		Corrections completed		
		Needed	Not needed	All	Some	None
Number	49	25	24	24	1	0
Percent	100	51.0	49.0	[a] 96	4.0	0

[a] Based on 25 = 100% those needing corrections.

Note: Rechecks were not made on dental units because major defects were corrected at the time of the physical survey.

Summary: No consultation beyond initial survey:
47.2% of offices needed corrections.
96% of offices needing corrections were corrected by the survey team (filtration and collimation).

Comment: Because of the ease of making corrections to dental units and the relatively small cost, these corrections should be done by the survey team. A periodic recheck as a stimulus to the practitioner to observe safety rules is recommended for the most productive continuing program.

Communication With Practitioner

As a basis on which to improve our own approach, the form attached as appendix 16 was designed and used at each medical (M.D.) office that participated in both the physical survey and patient data record keeping portion of the study. Although five offices are recorded as not having kept records, they either began and later decided to stop or were asked to stop for various reasons, such as poor record keeping or illness that would postpone record keeping for too long. The questions were memorized and asked in general conversation with the practitioner or technician, and the answers were recorded as soon as the interviewer left the office. This method, rather than recording answers during the interview, was believed to be the best for obtaining unrestrained opinions.

Questions in table 19 were asked in each office where no changes had been made or where only part of the recommended changes had been made. A total of 24 offices fell in this category.

Questions in table 20 were asked in all offices during the first revisit, regardless of whether changes had been made or not. Tabulations of answers given in 32 offices are shown in table 20.

Table 19. --Followup Questions and Answers by Personal Interview
(Where only some changes had been made, or none at all)

Question	Answer	Percent
(1) Why were changes not made?	a. Too busy	20.8
	b. X-ray technician did not see report; he looks after x-ray room	16.7
	c. Still under consideration	16.7
	d. No reason given	12.4
	e. Case load too low to justify changes	8.3
	f. Changes not considered essential or urgent	8.3
	g. Cost too much	4.2
	h. Unit owned by someone else	4.2
	i. Serviceman given report but has not made changes	4.2
	j. Planning to retire soon	4.2
	Total	100.0
(2) When will changes be made?	a. 2 to 6 weeks	87.5
	b. No direct answer	12.5
	Total	100.0

Note: Based on 24 interviews.

The following annotated conclusions were drawn from tables 19 and 20:

Table 19

1. The most frequent reason given for not having made changes was that the practitioner or office was too busy. Our task as public health workers was to show that making needed corrections is even more important in a busy office.

Table 20. --Followup Questions and Answers by Personal Interview (Whether or not changes had been made)

Question	Answer	Percent
(1) Were the recommendations clearly understood?	a. Yes b. No	100.0
(2) Was a serviceman readily available?	a. Yes b. No	100.0
(3) Did you feel the recommendations were practical and necessary as well as conforming with National Bureau of Standards Handbook 76(6) and the Florida State Sanitary Code?	a. Yes b. No	100.0
(4) Did the survey or record keeping unduly inconvenience you or your staff?	a. Yes b. No	100.0
(5) Did the record keeping, which was designed to aid our research part of the study, have any beneficial effect to you or your staff, i.e., incidental to its primary purpose?	a. Yes b. No c. Did not keep records d. Record keeper no longer employed	62.5 15.6 15.6 6.3
(6) What could we do to assist you the most in making the changes we recommend?	a. Nothing more b. Something more	93.7 6.3
(7) In your estimation, is this x-ray survey a worthwhile program?	a. Yes b. No	100.0
(8) Would you have preferred that we telephoned before coming for a recheck or come unannounced or does it make any difference?	a. Makes no difference b. Come unannounced c. Telephone first	68.7 21.9 9.4

Note: Based on 32 interviews.

2. A majority of practitioners gave a definite time when changes would be made, probably because they were asked for a definite time. It is our opinion, and it was borne out in subsequent rechecks, that the practitioner feels a greater obligation or determination to fulfill his commitment when a definite

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time is given. The surveyor should try to get a positive statement on this item.

Table 20

1. Recommendations were given in a clear and concise manner. Copies of forms used for this are attached as appendix 11.
2. There was no problem in obtaining service in this area when it was requested.
3. No one questioned the value of the recommendations. The team was accepted as authority on these matters.
4. Some said the record keeping involved extra work but none said that it unduly inconvenienced them or disrupted their established office procedure. This would indicate that studies of this type can be accomplished, with good acceptance by the practitioners.
5. Those who said the record keeping helped them or their staff or office listed such benefits as:

a. More attention now given to procedures,
b. More alertness to safety measures,
c. Better records for reference,
d. Fewer x-rays necessary,
e. Good training for new technician.

6. Of the few who said there was something more we could do to help, the most frequent suggestions were:

a. List the most important recommendation first and others in order of decreasing importance; then, if I can only afford one change I will make the most urgent one.
b. More verbal explanation is necessary.
c. Come back to recheck more often; everyone needs a little prodding.

7. Every office agreed that an x-ray study of this type was worthwhile. This question had a good effect in that it initiated positive thinking toward the study by the practitioner or his staff.
8. In rechecking an office, it appears that it makes no difference to the majority whether one calls first or comes unannounced. By this time they already know the investigator and why he is there; very likely a good relationship was established

during the initial physical survey. It is interesting that some even requested the investigator to come unannounced rather than telephone first. We recommend making recheck visits unannounced on the basis of this study, unless there are circumstances indicating the need for a telephone call.

Patient Data

The practitioner or an assistant recorded data on each x-ray patient for a typical 4-week period. This period may be rightfully considered as an average 4 weeks since it is the aggregate covered by such factors as seasonal variations, vacations, local preemployment examinations, and other influences on the normal x-ray case load. Consequently, one would be justified in multiplying by 13 the total number of patients and exposures for this period to obtain the approximate yearly figure. We have elected to report the actual figures recorded for the 4-week period.

In tables identified as "Medical" (tables 21-27), data on physicians (M.D.), osteopaths, chiropractors, hospitals, and the health department were treated together because these categories of practitioners use the same type of equipment and make essentially the same type of exposures. Podiatrists were included where appropriate. Tables 28-31 were prepared separately for the dentists because the type of x-ray equipment used and the type of exposures made are basically different from others. However, all categories of practice were combined in the total number of patients, exposures, and other appropriate tabulations.

Again, it should be noted that the tables selected for presentation in this report represent only a portion of the total number of informative tables that could be developed from the IBM cards.

Table 21.--Medical X-Ray Patients by Age, Race, Sex, and Residence

(Typical 4-week period)

Age	White						Nonwhite						Total
	Male			Female			Male			Female			
	Polk County	Other county	Other State	Polk County	Other county	Other State	Polk County	Other county	Other State	Polk county	Other county	Other State	
Under 15	150	2	84	4	1	0	7	2	0	5	1	0	256
15-29	283	23	4	158	16	2	29	1	0	15	1	0	532
30-44	228	29	5	152	28	2	25	5	1	35	3	0	513
45-64	279	18	1	316	44	1	42	2	0	15	1	0	719
65 and over	134	25	3	174	15	5	7	1	2	2	1	0	369

Number of mobile chest x-ray patients not included above 2,395

Total 4,784

Note: Tabulation based on offices participating in study; percentage shown elsewhere in report.
No age breakdown made for mobile chest x-ray patients. Figures include both radiograph and fluoroscope.

Table 22. --Medical X-Ray Examinations by Type and Age

(Typical 4-week period)

Age	Type of examination							Total	Percentage
	Head	Neck, shoulder, upper extremities	Chest	Spine	Abdomen	G. U.	Pelvis, hip, lower extremities		
Under 15	138	306	172	30	32	18	213	909	14.0
15-19	76	238	264	299	106	53	241	1,277	19.7
30-44	80	220	335	304	290	74	169	1,472	22.7
45-64	107	240	466	281	465	96	249	1,904	29.4
65 and over	36	99	285	94	261	56	93	924	14.2
Mobile chest x-ray unit	0	0	2,395	0	0	0	0	2,395	--
Total	437	1,103	3,917	1,008	1,154	297	965	8,881	100.0
Percentage	4.9	12.5	44.2	11.3	13.0	3.3	10.8	100.0	

[a] All races; both sexes.

Note: Figures above include both radiographic and fluoroscopic examinations made by physicians (M.D.), osteopaths, chiropractors, podiatrists, and hospitals. It includes total number of chest x-rays made by health department during same period of time, but not by age as no age breakdown was available. Percentages for age groups are based on a total of 6,486 and do not include the mobile x-ray unit caseload.

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Table 23. --Medical Diagnostic X-Ray Exposures by Type and Place
(Typical 4-week period)

Examination	Hospital	Office	Health Dept.	Total	Percentage
Head	230	207	0	437	4.9
Neck, shoulder, upper extremeties	343	760	0	1,103	12.5
Chest	724	798	2,395	3,917	44.2
Spine	263	745	0	1,008	11.3
Abdomen	785	369	0	1,154	13.0
G.U.	205	92	0	297	3.3
Pelvis, hip, lower extremities	350	615	0	965	10.8
Total	2,900	3,586	2,395	8,881	100.0
Percentate	32.6	40.4	27.0	100.0	

Table 24. --Medical Radiographic Chest X-Ray Patients
(Typical 4-week period before correction)

Category of practitioners	No. of patients	No. of exposures	No. of patients					
			Beam size		Filtration		Beam alignment	
			Adequate[a]	Inadequate	Adequate[b]	Inadequate	Adequate[c]	Inadequate
(M.D.):								
G.P.	30	38	27	3	4	26	4	26
Internal	221	229	221	0	148	73	111	110
Surgery	34	36	21	13	8	26	13	21
Urology	0	0	0	0	0	0	0	0
Radiology	123	135	50	73	92	31	123	0
Gyn. & Ob.	1	1	1	0	0	1	0	1
Orthopedics	8	20	0	8	0	8	0	8
Hospital	414	718	277	137	384	30	29	385
Health Dept	2,395	2,395	0	2,395	2,395	0	2,395	0
Osteopath	0	0	0	0	0	0	0	0
Chiropractor	4	4	2	2	3	1	3	1
Total	3,230	3,576	599	2,631	3,034	196	2,678	552
Percentage	100	100	18.5	81.5	93.9	6.1	82.9	17.1

[a] Adequate beam size is 24-in. diameter or under, or equivalent rectangle.
[b] Adequate filtration is 2.5 mm. aluminum equivalent or over.
[c] Adequate means of beam alignment is presence of some physical apparatus capable of aligning x-ray beam with relation to plane of film.

Table 25. --Medical Radiographic Chest X-Ray Patients
(Typical 4-week period after correction)

Category of practitioners	No. of patients	No. of exposures	No. of patients					
			Beam size		Filtration		Beam alignment	
			Adequate [a]	Inadequate	Adequate [b]	Inadequate	Adequate [c]	Inadequate
(M.D.)								
G.P.	30	38	30	0	21	9	20	10
Internal	221	229	221	0	221	0	161	60
Surgery	34	36	24	10	34	0	22	12
Urology	0	0	0	0	0	0	0	0
Radiology	123	135	123	0	123	0	123	0
Gyn. & Ob.	1	1	1	0	0	1	0	1
Orthopedics	8	20	0	8	8	0	0	8
Hospital	414	718	414	0	414	0	321	93
Health Dept.	2,395	2,395	2,395	0	2,395	0	2,395	0
Osteopath	0	0	0	0	0	0	0	0
Chiropractor	4	4	2	2	3	1	3	1
Total	3,230	3,576	3,210	20	3,219	11	3,045	185
Percentage	100	100	99.4	0.6	99.6	0.4	94.2	5.8

[a] Adequate beam size is 24-in. diameter or under, or equivalent rectangle.
[b] Adequate filtration is 2.5 mm. aluminum equivalent or over.
[c] Adequate means of beam alignment is presence of some physical apparatus capable of aligning x-ray beam with relation to plane of film.
Note: This table is based on estimated numbers.

Table 26. --Medical Fluroscopic Patients
(Typical 4-week period before corrections)

Category of practitioner	No. of patients	No. of exposures (incl. spot films)	No. of patients					
			Target-to-table-top distance		Filtration		Means of dark adaptation	
			Adequate [a]	Inadequate	Adequate [b]	Inadequate	Adequate [c]	Inadequate
(M.D;)								
G.P.	1	2	0	1	0	1	0	1
Internal	23	45	23	0	1	22	1	22
Surgery	1	1	1	0	1	0	0	1
Urology	0	0	0	0	0	0	0	0
Radiology	103	112	103	0	103	0	103	0
Gyn. & Ob.	0	0	0	0	0	0	0	0
Orthopedics	0	0	0	0	0	0	0	0
Hospital	157	634	157	0	157	0	134	23
Health Dept.	0	0	0	0	0	0	0	0
Osteopath	0	0	0	0	0	0	0	0
Chiropractor	0	0	0	0	0	0	0	0
Total	285	794	284	1	262	23	238	47
Percentage	100	100	99.7	0.3	91.9	8.1	83.5	16.5

[a] Adequate tube target-to-tabletop distance is 12 in. or over.
[b] Adequate filtration is 2.5 mm. aluminum equivalent or over.
[c] Adequate means of dark adaptation is use of red goggles or dark room with no light leaks.

Table 27.--Medical Fluoroscopic Patients
(Typical 4-week period after correction)

Category of practitioners	No. of patients	No. of exposures (incl. spot films)	No. of patients					
			Target-to-table-top distance		Filtration		Means of dark adaptation	
			Adequate[a]	Inadequate	Adequate[b]	Inadequate	Adequate[c]	Inadequate
(M.D.)								
G.P.	1	2	0	1	1	0	0	1
Internal	23	45	23	0	23	0	1	22
Surgery	1	1	1	0	1	0	0	1
Urology	0	0	0	0	0	0	0	0
Radiology	103	112	103	0	103	0	103	0
Gyn. & Ob.	0	0	0	0	0	0	0	0
Orthopedics	0	0	0	0	0	0	0	0
Hospital	157	634	157	0	157	0	134	23
Health Dept.	0	0	0	0	0	0	0	0
Osteopath	0	0	0	0	0	0	0	0
Chiropractor	0	0	0	0	0	0	0	0
Total	285	794	284	1	285	0	238	47
Percentage	100	100	99.7	0.3	100	0	83.5	16.5

[a] Adequate tube target-to-tabletop distance is 12 in. or over.
[b] Adequate filtration is 2.5 mm. aluminum equivalent or over.
[c] Adequate means of dark adaptation is use of red goggles or dark room with no light leaks.
Note: This table is based on estimated numbers.

Table 28. --Dental X-Ray Patients by Age, Race, Sex, and Residence
(Typical 4-week period)

Age	White						Nonwhite						Total
	Male			Female			Male			Female			
	Polk County	Other county	Other State	Polk County	Other county	Other State	Polk County	Other county	Other State	Polk County	Other county	Other State	
Under 15	138	5	1	129	5	0	2	4	1	3	6	0	294
15-29	146	8	10	213	15	3	12	2	0	19	6	0	434
30-44	124	7	0	148	11	1	8	7	0	13	7	0	326
45-64	107	6	2	146	13	5	7	3	0	12	4	1	306
65 and over	28	3	4	30	2	3	6	0	1	2	1	0	80
Total	543	29	17	666	46	12	35	16	2	49	24	1	1,440
Percent	37.7	2.0	1.2	46.3	3.2	0.8	2.4	1.1	0.1	3.4	1.7	0.1	100

Note: Tabulation based on offices participating in study; percentage shown elsewhere in report.

Table 29.--Dental X-Ray Patients by Type and Age

(Typical 4-week period)

Age	Type of examination							Total	Percentage
	Bitewing	Periapical	Lateral jaw	Cephalo-metric	Occlusal	Panoramic	Other		
Under 15	372	640	82	0	0	0	3	1,097	23.6
15-29	506	554	15	0	0	0	18	1,093	23.4
30-44	341	722	0	0	1	0	30	1,094	23.4
45-64	220	886	2	0	0	1	45	1,154	24.8
65 and over	48	172	0	0	0	1	2	223	4.8
Total	1,487	2,974	99	0	1	2	98	4,661	100
Percentage	31.9	63.82	2.12	0	.02	.04	2.1	100	

[a] All races; both sexes.

Note: Tabulations based on offices participating in study; percentage shown elsewhere in report.

Table 30.--Dental X-Ray Patients
(Typical 4-week period before corrections)

Category	No. of patients	No. of exposures	No. of patients			
			Beam diameter		Filtration	
			Adequate[a]	Inadequate	Adequate[b]	Inadequate
General practice	1,034	3,437	1,010	24	744	290
Orthodontic	90	226	86	4	59	31
Pedodontic	165	493	155	10	138	27
Prosthodontic	151	505	145	6	115	36
Total	1,440	4,661	1,396	44	1,056	384
Percentage	100	100	96.9	3.1	73.4	26.6

[a] Adequate beam diameter is less than 3 in.
[b] Adequate filtration is at least 1.5 mm. of aluminum equivalent for 70 kv. units and 2.5 mm. for 90 kv. units.

Note: This table is based on estimated numbers.

Table 31.--Dental X-Ray Patients
(Typical 4-week period after corrections)

Category	No. of patients	No. of exposures	No. of patients			
			Beam diameter		Filtration	
			Adequate[a]	Inadequate	Adequate[b]	Inadequate
General practice	1,034	3,437	1,034	0	1,034	0
Orthodontic	90	226	90	0	90	0
Pedodontic	165	493	165	0	165	0
Prosthodontic	151	505	151	0	151	0
Total	1,440	4,661	1,440	0	1,440	0
Percentage	100	100	100	0	100	0

[a] Adequate beam diameter is less than 3 in.
[b] Adequate filtration is at least 1.5 mm. of aluminum equivalent for 70 kv. units and 2.5 mm for 90 kv. units.

Note: This table is based on estimated numbers.

IX. REDUCTION IN X-RAY EXPOSURE TO POPULATION

Reduction in x-ray exposure has been calculated on the basis of the number of patients affected by the physical corrections made to the x-ray unit used. No attempt has been made to assess dose or even reduction in area irradiated as these factors were not within the scope of this study. When a practitioner secured a cone for chest x-rays that reduced the original beam diameter at the plane of the film from 38 inches to 22 inches, the square-inch reduction of x-ray beam could be calculated. However, the portion of this beam actually striking the patient at 38 inches diameter versus 22 inches diameter is unknown for several reasons, including incomplete information on beam alignment. Even when the weights and heights are known of all the x-ray patients for a typical period of time, there are still differences in head and shoulder sizes of persons with identical weights and heights. Therefore, it would be difficult to give a precise tabulation of reduction in exposure on a square-inch basis of area irradiated. However, according to Dr. Russell Morgan of Johns Hopkins University (10), an estimate of square-inch reduction can be obtained with an acceptable degree of accuracy when the above data are known.

Based on the tabulations and qualifying remarks in the previous section of this report, the following summaries of patients affected are presented.

Table 32. --Unnecessary Radiation Exposure Before Corrections

	Beam size inadequate	Filtration inadequate	Alignment inadequate	Target-to-tabletop distance inadequate	Dark adaptation inadequate	Total No. patients [a]
Chest	2,631	196	552	--	--	2,826
Fluoroscopy	--	23	--	1	47	47
Dental	44	384	--	--	--	384
Total	2,675	603	552	1	47	3,257

[a] Total number of patients is smaller than total of combined columns if same patient in some instances was subjected to one or more inadequate conditions at same time or during same exposure.

Table 33. --Unnecessary Radiation Exposure After Corrections

	Beam size inadequate	Filtration inadequate	Alignment inadequate	Target-to-tabletop distance inadequate	Dark adaptation inadequate	Total No. patients [a]
Chest	20	11	185	--	--	185
Fluoroscopy	--	0	--	1	47	47
Dental	0	0	--	--	--	0
Total	20	11	185	1	47	232

[a] Total number of patients is smaller than total of combined columns if same patient in some instances was subjected to one or more inadequate conditions at same time or during same exposure.

RESULTS:

3,257 persons received unnecessary irradiation before corrections.

232 persons received unnecessary irradiation after corrections.

3,025 persons benefited.

Percentage: $\frac{3025}{3257} \times 100\% = 92.8\%$

Therefore, a reduction in unnecessary exposure to 92.8 percent of the persons receiving x-rays in this study was effected during the course of the survey and consultation program. It should be noted that all corrections were made by the practitioners themselves rather than by the survey team (with the exception of dental offices). If the survey team for this study had furnished aluminum filtration and installed it at the time of the survey, the reduction in population exposure would be even greater since more corrections would have been effected. This study shows the results of voluntary corrections made by the practitioners but instigated and stimulated by the health department.

X. TRANSFER OF FINDINGS TO DATA PROCESSING CARDS

Part of the scope of this study included the development of a system to tabulate and analyze the data obtained. This was done by the formulation of coding and punching instructions for five different sets of data, namely:

Medical x-ray physical survey,
Medical x-ray patient data (radiographic),
Medical x-ray patient data (fluoroscopic),
Dental x-ray physical survey,
Dental x-ray patient data (radiographic).

The completed cards totalled approximately 12,000. Duplicate sets of cards are on file with the Florida State Board of Health in Jacksonville and the Division of Radiological Health, Public Health Service, Rockville, Md.

Because it would not be feasible to include in this report every type of tabulation that could be produced from these cards, only basic tables of immediate interest are presented. For those interested in a particular analysis not included in this report, the IBM cards may be utilized to produce the data. For example, supplementary data which can be tabulated from the cards might include:

1. Number of female patients between the ages of 15 and 45 who received a chest x-ray where the beam diameter at the plane of the film exceeded 40 inches, or
2. Number of nonwhite male patients receiving fluoroscopic examinations on units where the shutters did not function properly.

A great variety of exposure factors can be tabulated by reviewing the items listed below and choosing any combination of these from the IBM cards.

All data on a patient relate only to the particular x-ray machine used on the patient, and a card is available describing the physical characteristics of this particular machine. Briefly, information

of the following type is available from the IBM cards and is tied together in a patient - x-ray machine relationship:

From records kept in each office:

General patient data:

1. Total number of x-ray patients per month
2. Age
3. Height
4. Weight
5. Race
6. Sex
7. Residence

Fluoroscopy patient data:

8. Type of examination
9. Projection
10. Kvp.
11. Ma-min.
12. Field size
13. Anatomical emphasis
14. Thickness of part
15. Number of spot films

Radiographic patient data:

16. Type of examination
17. Projection
18. Kvp.
19. Ma-sec.
20. Cone size
21. Target-to-film distance
22. Thickness of part
23. Film size
24. Grid used
25. Screen used

From physical survey of each x-ray machine:

General physical data:

1. Type of x-ray unit
2. Type of installation
3. Type of practice
4. Type of personnel monitoring

Fluoroscopy physical data:

5. Type of dark adaptation
6. Lead aprons used
7. Lead gloves used
8. Accessory protective devices used
9. Radiation warning indicator used
10. Manually reset cumulative timer used
11. Type of fluoroscope
12. Function of shutters
13. Normal operating control settings
14. Primary beam limited to screen
15. Target-to-panel distance
16. X-ray transmission through screen
17. Total filtration before and after modification
18. Roentgen output in r./min.

Radiography physical data:

19. Type of unit
20. Beam centering device present
21. Radiation warning indicator present
22. Type of kv. and ma. indicator
23. Type of tube housing
24. Type of timer and functions
25. Cones available and beam dimensions
26. Protective devices (operator and/or patient)
27. Roentgen output in r./sec. at stated kvp., ma., and distance
28. Total filtration before and after modification

This review points up the versatility and essentially endless number of combinations that may be tabulated and studied because there is a patient-machine correlation.

The coding of the physical surveys of both medical and dental units was done by the staff of this study. The coding of all patient data and the punching of all IBM cards was subcontracted to Data Processing Bureau, Inc., of Winter Haven, Fla. This firm carried out its three functions of coding, punching, and standard verification under the close supervision of the field project officer and consultants from the Public Health Service, Division of Radiological Health, Rockville, Md. All tabulations made from the cards and all duplicate sets of cards were supplied by the Division of Radiological Health. The IBM cards containing the physical survey and patient data correlated together can provide

the means of tabulating any exposure-factor data accumulated during this study and are readily accessible from the sources mentioned. These cards, along with coding and punching instructions, can be obtained from the Division of Radiological Health.

XI. BENEFITS TO STATE AND LOCAL HEALTH DEPARTMENTS

Every specialized study gives both tangible and intangible benefits to many people and organizations. In this case some specific advantages were observed and some reported by members of the Polk County Health Department and the Florida State Board of Health. Although these items are cited for this particular study, it is fair to assume they would be realized as advantages elsewhere in connection with similar studies. The benefits included the following:

To local health department of county:

1. Survey of 91.5 percent of all x-ray installations in county with followup program,
2. Availability of project staff as resource persons in radiological health,
3. Availability of instruments for loan and demonstration purposes,
4. Completion of a local project in radiological health (which the local health department would not have been able to undertake at this time),
5. Demonstration of what the local department could do by itself, with one experienced staff member and perhaps one trainee,
6. Creation of awareness of problems incident to the increasing use of various sources of ionizing radiation.

To State board of health:

1. Asset to ongoing State program,
2. Availability of specific information needed on some aspect of radiation protection,
3. Further emphasis on radiological health as a component of a total public health program.

General benefits:

1. Practitioners now call the Health Department office as a consultative resource in matters dealing with radiological health. Examples of questions that have been asked include the following:

a. Where should I position x-ray machine in new quarters I am moving into?

b. I want to buy a dosimeter. What range do I need?

c. I am getting spots on my film. Can you tell me the cause?

d. Can you supply me with resource material to aid in the preparation of a lecture?

2. Practitioners in adjoining counties have heard of the survey and have requested that we examine their units.

Many additional incidental items could be cited but the main point is to show the numerous and varied benefits from studies of this nature, even beyond the stated terms of the contract under which the study was made.

XII. COST OF STUDY

The actual cost of a study done in cooperation with an already existing agency or program is difficult to determine. For example, someone from a local health department or State board of health assists in some part of the program. It must be decided whether or not his remuneration should be added to the total cost of the study along with the prorated cost of the equipment he used. Many other indeterminable items occur in such a study. Obviously, computations of this type are too complicated to be entered into here, and it is well understood that agencies and personnel who cooperate with each other will eventually cancel out any time or help given by one to the other. Certainly this is true for this particular study. Therefore, the following breakdown on the cost of this study is presented to show how much and for what items actual contract money was spent.

In items where the amounts could be conveniently documented, they are exact. In other cases, the amounts are estimated but are considered approximately correct.

Table 34.--Cost of Study

Item	9/61 - 8/62 1st year	9/62 - 8/63 2nd year
Salary of stenographer (7.5 mo. 1st yr.) ..... (12 mo. 2nd yr.)	$2,025	$3,315
Salary of P. H. physicist tech. (6 mo. 1st yr.) . (9 mo. 2nd yr.).	1,890	2,880
Office rent (includes utilities; 9 mo. 1st yr.)...	900	1,200
Office equipment rental.....	140	180
Office supplies	160	230
Travel of staff in county	600	900
Travel of staff in State.....	200	300
Travel of staff out of State.....	150	80
Travel of director	200	200
Telephone	120	180
Consultation.....	450	0
Record keeping by practitioners.....	525	675
Overhead	800	800
Transfer of data to IBM cards	0	900
Tabulation of data from IBM cards (USPHS)	0	0
Photodocumentation of study (USPHS)	0	0
Salary of field project officer (USPHS)	0	0
Field x-ray survey kit (USPHS).....	0	0
	$8,160	$11,840

	$8,160
	11,840
Total.....	$20,000

It is to be noted that the field project officer, who is an assignee from the Public Health Service, is paid by the U.S. Department of Health, Education, and Welfare. If one planned to hire a person to direct and coordinate the field activities in lieu of a Public Health Service assignee, then this person's salary would be added to the yearly amounts. Travel items do not include capital outlay for automotive vehicles. Also if one had to purchase a field survey kit this would entail an added cost of $1,300. One may or may not have facilities for transfer of data to IBM cards.

In this study it was more feasible to contract it than to use the State Board of Health facilities. In any case there would be a cost.

Photodocumentation of a study is an asset but not a necessity. In this instance it supplied both the Public Health Service and Florida State Board of Health with a series of photographs (section VII) and corresponding slides that can be used for illustrations in reports, training, speeches, and exhibits.

As mentioned earlier, to physically house the personnel of this study, offices were rented in a county building. This building is separate from the local health department building and presented the greatest area for a reasonable rental. This arrangement also created a field office from which other members of the Division of Radiological Health of the State Board of Health could work. When adequate office space can be secured in a local or State health department building, the amount spent for office rent could be deducted from the total cost and possibly be included in overhead.

It would be unfair to divide the total cost of the study by the number of units surveyed and use this as a basic cost per unit. The objectives sought and achieved were too many to justify such simple accounting. The total number of x-ray units might be divided into the total cost and this considered the cost per unit, to achieve not just the physical survey but all five of the following objectives:

1. Physical survey of unit,
2. Patient record of x-rays made from this unit for a 4-week period,
3. Intensive followup program to encourage changes and to determine if recommended changes had been made on this unit,
4. Transfer of physical and patient data from this unit to IBM cards,
5. Development of goodwill and cooperation of the user of this unit.

Again, this does not include the salary of the field project officer but represents the total amount of the authorized contract money and how it was spent.

It would be reasonable to suppose that studies of this type could be done in other counties or States in much less time and

therefore for less money per unit by utilizing the experience and methodology described in this study.

XIII. OBSERVATIONS, ATTITUDES, AND CONCLUSIONS

The initial visit to an office includes a physical survey of the installation, with measurements and the initiating of record keeping for a 4-week period. In an effort to keep conditions as they were found initially, no recommendations were made regarding corrections at the installation until the record-keeping period was complete. Even so, it was observed that changes were instituted simply as a result of our visit to the office and our making the physical survey, combined with having the x-ray technician or physician keep records. Some isolated items were:

1. Now using thermometer for developer temperature. Had assumed it was around 68° F., but found it was actually 74° F.
2. Was using wrong setting on variable aperture cone.
3. Found milliampere needle indicator was not correlated with knob setting. Had repair man fix this.
4. Now using variety of cones which were formerly stored away.
5. Started using film badge.
6. Now aligns patient and target with measuring tape; formerly estimated it and was off 6 inches.
7. Now measures thickness of part; formerly estimated.

This pointed up a direct positive effect of the study not anticipated in the planning--that having to record data about x-ray exposures makes one more aware of his equipment and personal exposure. This is shown in table 20 by question 5.

Table 35 shows attitudes recorded for the various categories of practice.

Table 35.--Recorded Attitudes of Practitioners and Staffs

	Physician (M.D.)	Osteo-path	Chiro-practor	Podia-trist	Hospital	Dentist
Attitude toward physical survey	Very Good	Fair	Very Good	Very Good	Very Good	Very Good
Attitude toward keeping records for subsequent 4 weeks	Good	Fair	Fair	Good	Good	Good
Attitude toward obtaining records for previous 4 weeks	Poor to Refusal	Poor	Fair	Fair	Poor	Poor

Note: These are observations the trained investigators made at the offices visited in this particular study and do not lend themselves to statistical treatment.

Conclusions

The following brief sentences sum up some of the conclusions derived from this study.

1. Practitioners of the healing arts will keep patient records of x-ray examinations for a reasonable period of time in order to help research efforts.
2. A single visit to an office to make a physical survey of the x-ray installation is not enough for an effective program of x-ray exposure reduction. At least one followup visit is necessary to obtain a respectable percentage of corrections.
3. The more often an office is visited, the better accepted the Health Department's survey personnel become and the more expected their next visit becomes. Therefore, visits can be made on a regular basis in a pleasant manner in a voluntary situation.
4. Equipment purchased by the practitioner must be checked to see if the serviceman supplied equipment with the recommended dimensions. This is particularly true in the case of new cones.
5. Sending a second letter to practitioners to request their cooperation in an x-ray study proves worthwhile.
6. Concise written recommendations combined with verbal explanations apparently make an effective way of reporting conditions found during the physical survey to the practitioner. This should be tested by further research.

7. Data are most conveniently and most accurately handled, and become more versatile, when placed on IBM cards.

8. Reduction in population exposure to x-radiation can be measured by studies of this type in terms of numbers of patients affected versus conditions found and corrections made.

For a long time there has been a need for improving the quality of the data from which estimates of the contribution of various sources of radiation to human populations may be made. This study was based on the premise that an investigation of a sampling of the practices in one State (limited to the use of x-rays in the diagnosis of human illness and to the development of a method of effectively reducing this exposure) would constitute a substantial contribution not only to exposure knowledge but also to the reduction or virtual elimination of nonbeneficial radiation incidental to diagnostic procedures. It has been demonstrated that studies of this type are feasible and will receive the active participation of the various professional groups practicing the healing arts.

REFERENCES

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2. Epp, E. R., J. M. Heslin, H. Weiss, J. S. Laughlin, and R. S. Sherman: "Measurement of Bone Marrow and Gonadal Dose from X-Ray Examinations of the Pelvis, Hip, and Spine as a Function of Field Size, Tube Kilovoltage, and Added Filtration," submitted to Public Health Service (June 1962).

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4. Senn, C. L., J. C. Rogers, J. Karbus, R. A. Miller, B. Ault, and G. Terhoeven: "Survey of X-Ray Facilities in Los Angeles," Public Health Service, Radiological Health Data IV: 215-20 (April 1963).

5. Stahl, W. R., R. R. Sullivan, and D. G. Wagstaff: "Findings of a Survey of X-Ray Units," Public Health Reports 75:652-58 (July 1960).

6. Blatz, H.: "X-Ray Exposures Found Excessive," New York Times (May 15, 1961).

7. Seagle, E. F.: "A Study of Radiation Exposure to Operators of X-Ray Equipment," The Health Bulletin, North Carolina State Board of Health 74:2-5 (October 1959).

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9. National Committee on Radiation Protection and Measurements: "Medical X-Ray Protection up to Three Million Volts," National Bureau of Standards Handbook 76, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (February 1961).

10. Personal communication from Dr. R. H. Morgan, Johns Hopkins University, to Dr. R. I. Pierce, Chief, State Assistance Branch, Division of Radiological Health, Public Health Service (1963).

Attendance at the First Planning Meeting
of the X-Ray Exposure Study
Winter Haven, Florida
October 29, 1961

Dr. E. G. Williams, Project Director and Director
Division of Radiological and Occupational Health,
Florida State Board of Health, Jacksonville

Dr. C. M. Sharp, Assistant State Health Officer,
Florida State Board of Health, Jacksonville

Mr. E. F. Seagle, Senior Sanitary Engineer, Public Health Service
(on loan to Florida State Board of Health),
Bartow, Field Project Officer

Mr. C. E. Roessler, Radiological Physicist,
Florida State Board of Health, Jacksonville

Dr. Walter Mauderli, Radiation Physicist,
University of Florida Medical School, Gainesville

Dr. Raymond Parks, Head, Department of Radiology,
University of Miami Medical School, Miami

Dr. Maxwell Dauer, Radiation Physicist,
Jackson Memorial Hospital, Miami

Dr. D. P. Griffith, Florida Urological Society,
Winter Haven

Dr. Fred Nichols, Florida State Dental Society,
St. Petersburg

Dr. E. C. Burns, Jr., Radiologist,
Polk County Medical Society, Lake Wales

Dr. James F. Cason, Health Director,
Polk County Health Department, Winter Haven

Dr. Ralph B. Hanahan, Radiologist,
Polk County Medical Society, Lakeland

Dr. Robert B. Nickau, Radiologist,
Polk County Medical Society, Lakeland

Dr. James T. Shelden, Radiologist,
Polk County Medical Society, Lakeland

Dr. Charles E. Curtiss, Radiologist,
Polk County Medical Society, Winter Haven

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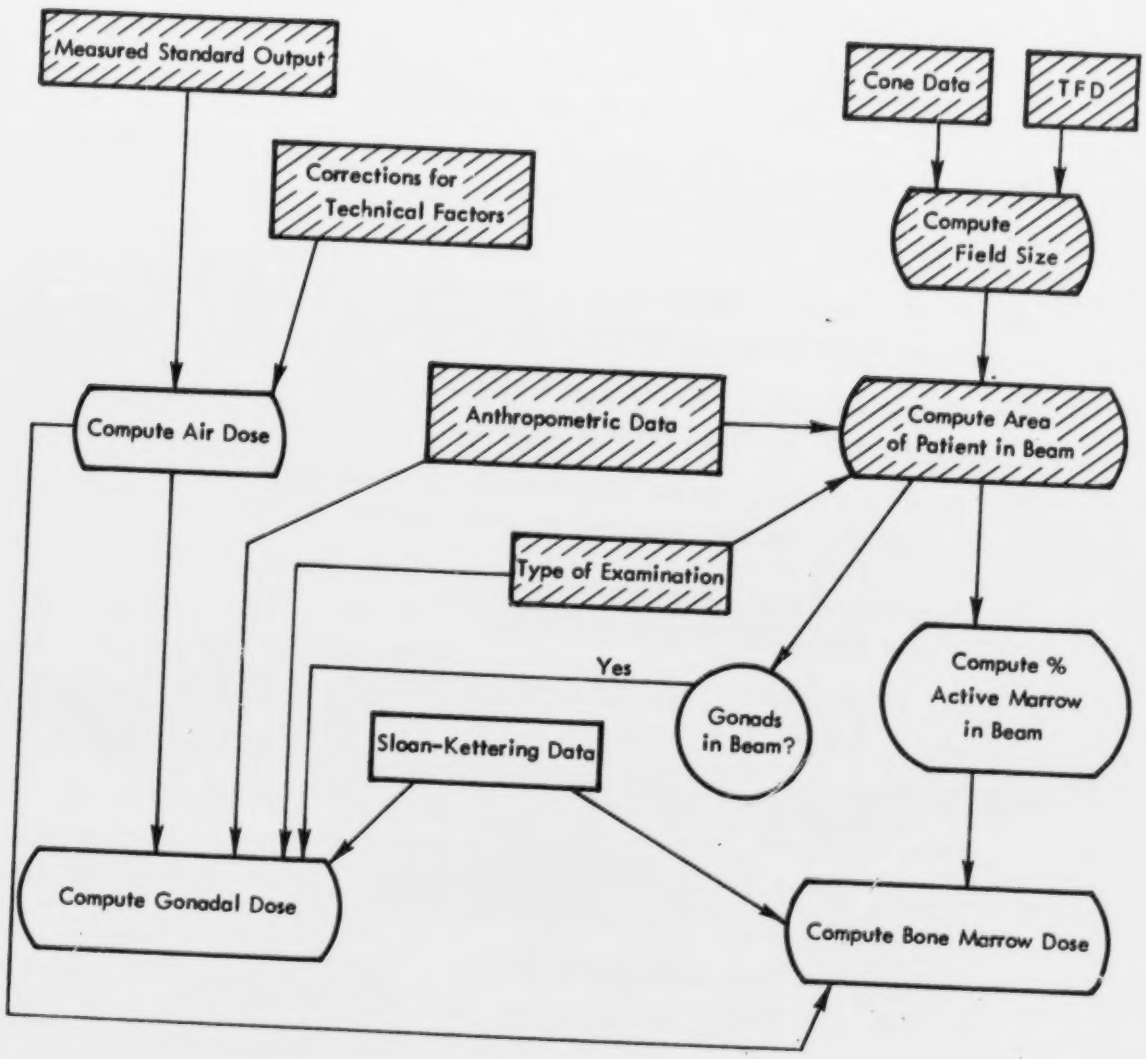
Appendix 2

DOSE COMPUTATION FLOW CHART FROM NEW YORK UNIVERSITY STUDY



Note: Shaded areas represent items covered in the Polk County, Fla., study.

PILOT STUDY LETTER

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, M. D.
864 Orangeland Avenue
Bartow, Florida

Dear Dr._____:

Several months ago the Polk County Health Department in conjunction with the State Board of Health initiated a plan to survey x-ray installations in Polk County for safety features designed to reduce stray or unwanted radiation to both physician and patient. The details of this program are now complete and we have the trained personnel and instrumentation to offer this service to a limited number of practitioners at no cost. Eventually, we hope to be able to make a physical survey of all x-ray installations for those who desire the service.

As a beginning, a small and random sample of physicians who own x-ray equipment in Polk County have been selected. Your office and your equipment are included in this random sample and we would appreciate your cooperation in this project. In addition to our checking your installation for safety features, we would ask your participation in keeping simple records of x-ray examinations for our research part of the study and your secretary or technician will be compensated by the Florida State Board of Health for the extra work in filling out the necessary forms.

You are assured that neither you, nor your office, nor your procedures will be identified in this study. The data obtained in your office will be lumped with that of other physicians who participate in this study and used strictly for statistical purposes.

Dr. James F. Cason, Director of the Polk County Health Department, has authorized me to ask for your cooperation in this matter. Please check the appropriate blank and mail the enclosed slip in the self-addressed stamped envelope and we will visit you within the next few weeks if you so desire.

Very truly yours,

Edgar F. Seagle
Radiological Engineer
Field Project Officer

Enclosures

EFS:bc

Appendix 4

FIRST MAIN STUDY LETTER (M.D.)

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, M. D.
864 Orangeland Avenue
Bartow, Florida

Dear Dr._____:

Several months ago the Polk County Health Department in conjunction with the State Board of Health initiated a plan to survey x-ray installations in Polk County for safety features designed to reduce stray or unwanted radiation to both physician and patient. The details of this program are now complete and we have the trained personnel and instrumentation to offer this service to the medical practitioners at no cost. Eventually, we hope to be able to make a physical survey of all x-ray installations for those who desire the service.

In addition to our checking your installation for safety features, we would ask your participation in keeping simple records of x-ray examinations for a limited period. These records would be of great value to us in our research part of the study, and your secretary or technician will be compensated by the Florida State Board of Health for the extra work in filling out the necessary forms.

You are assured that neither you, nor your office, nor your procedures will be identified in this study. The data obtained in your office will be lumped with that of other physicians who participate in this study and used strictly for statistical purposes.

Dr. James F. Cason, Director of the Polk County Health Department, has authorized me to ask for your cooperation in this matter. Please check the appropriate blank and mail the enclosed slip in the self-addressed stamped envelope and we will visit you within the next few weeks if you so desire.

Very truly yours,

Edgar F. Seagle
Radiological Engineer
Field Project Officer

EFS:bc

Enclosures

SECOND MAIN STUDY LETTER (M.D.)

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, M. D.
864 Orangeland Avenue
Bartow, Florida

Dear Dr. _____:

About one month ago we wrote to you regarding the joint Polk County Health Department - State Board of Health plan to survey x-ray installations in Polk County for safety features. The survey is still underway and there are only a few practitioners whom we have not heard from.

To better enable us to evaluate the effectiveness of this program, would you please check the appropriate blank and mail the enclosed slip in the self-addressed stamped envelope. Should you wish the service, we could visit you within the next few weeks. Our trained personnel have the instrumentation to completely check all types of x-ray units and make recommendations to reduce stray or unwanted radiation to both physician and patient. There is no charge for this service.

Thank you for your consideration and reply.

Very truly yours,

Edgar F. Seagle
Radiological Engineer

For: E. G. Williams, M. D., Director
Division of Radiological and
Occupational Health

EFS:bc

Enclosures

FIRST MAIN STUDY LETTER (OTHER CATEGORIES)

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, (D. C.) (D. O.) (D. S. C.) (D. D. S.)
576 Fruitland Street
Bartow, Florida

Dear Dr. _____:

Several months ago the Polk County Health Department in conjunction with the State Board of Health initiated a plan to survey x-ray installations in Polk County for safety features designed to reduce stray or unwanted radiation to both practitioner and patient. The details of this program are now complete and we have the trained personnel and instrumentation to offer this service to all practitioners of the healing arts at no cost. We plan to make a physical survey of all x-ray installations for those who desire the service.

Dr. James F. Cason, Director of the Polk County Health Department, has authorized me to ask for your cooperation in this matter. Please check the appropriate blank and mail the enclosed slip in the self-addressed stamped envelope and we will visit you within the next few weeks if you so desire.

Very truly yours,

Edgar F. Seagle
Radiological Engineer
Field Project Officer

EFS:bc

Enclosures

SECOND MAIN STUDY LETTER (OTHER CATEGORIES)

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, (D. C.) (D. O.) (D. S. C.) (D. D. S.)
576 Fruitland Street
Bartow, Florida

Dear Dr. _____:

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To better enable us to evaluate the effectiveness of this program, would you please check the appropriate blank and mail the enclosed slip in the self-addressed stamped envelope. Should you wish the service, we could visit you within the next few weeks. Our trained personnel have the instrumentation to completely check all types of x-ray units and make recommendations to reduce stray or unwanted radiation to both practitioner and patient. There is no charge for this service.

Thank you for your consideration and reply.

Very truly yours,

Edgar F. Seagle
Radiological Engineer

For: E. G. Williams, M. D., Director
Division of Radiological
and Occupational Health

EFS:bc

Enclosures

SURVEY EQUIPMENT

Item	Measurement
Fluorescent Strips	X-ray beam dimension at plane of film; Beam size at fluoroscope screen
Victoreen R-Meter w/ 2-25 r chambers	Dose rate at table or panel top of fluoroscope units;
Victoreen R-Meter w/ 2-25 r chambers and aluminum shield	Determination of total aluminum equivalent filtration in path of x-ray beam.
NUCOR Ionization Chamber Survey Instrument	Estimate of exposure levels at various positions, both outside and within the installation; Presence of leaded glass in fluoroscopic screen; Leakage of radiation through x-ray tube housing.
Micrometer	Thickness of added filtration.
Flexible Steel Tape Measure	Determination of field size in use of collimators by measurement and calculation; Checking target to table top and table top to viewing device distances on fluoroscopic machines; Determining target to r-chamber distance.
Sheet Lead Absorber (4" x 4" x 1/16")	Obtain a 4" x 4" size beam at fluoroscope table top for beam quality measurements; To standardize scatter radiation survey procedures.
Lead x-ray Tube Port Plug	Blocking x-ray tube port in checking for leakage.
Stop Watch	Exposure time in determining table top dose rate of fluoroscope machines; Accuracy of mechanical timers.
Wooden Phantom (10" x 12" x 3")	Used to simulate a patient in measurement of scattered radiation.
Leaded Apron	Protection of inspector of fluoroscope machines.

Physical Survey Form Used

MEDICAL X-RAY SURVEY

1. _____

2. STATE
COUNTY, CITY

_____
NAME OF USER(S)

_____
INSTALLATION ADDRESS

_____
PHONE NUMBER

_____
CITY

_____
COUNTY

_____
STATE

_____
NAME OF SURVEYOR

3. CARD
IDENTIFICATION

_____

4. ARE X-RAY UNITS REGISTERED
WITH STATE HEALTH DEPARTMENT?
YES_____ NO_____

5. TYPE OF RADIATION SOURCES AT
INSTALLATION & NUMBER
Photofluorography No._____
Radiography No. (Med. & Dental) _____
Fluoroscopy No. _____
Tomography No. _____
Cineradiography No. _____
Therapy No. _____
Radioactive Materials_____

6. DATE OF SURVEY
(Month/Day/Year)_____

7. TYPE OF INSTALLATION
1. Hospital ____
2. Group practice____
3. Private ____
4. Mobile ____
9. Other (specify)____

8. TYPE OF PRACTICE
0. None ____
1. General Practitioner ____
2. Internal Medicine ____
3. Obstetrics-Gynecology ____
4. Orthopedic Surgery ____
5. Pediatrics ____
6. Radiology ____
7. Surgery ____
8. Urology ____
9. Other (specify) ____

9. PERSONNEL MONITORING

A. TIME
0. None ____
1. Currently being used ____
2. Was used within the past 12 months ____
3. Was used over 1 yr ago ____

B. TYPE
0. None ____
1. Film Badge ____
2. Pocket Chamber ____
3. Pocket Dosimeter ____
4. Dental Film ____
9. Other (specify) ____

C. RESULTS
0. None ____
1. Undetermined ____
2. Below 25 mr/wk ____
3. 25 to 100 mr/wk ____
4. Above 100 mr/wk ____

10. FURTHER CONSULTATION RECOMMENDED
0. No _____ 1. Yes _____ (See Remarks)

DIAGNOSTIC RADIOGRAPH SURVEY

IDENTIFICATION

LOCATION OF PHYSICAL EQUIPMENT _____
(Attach Sketch if Necessary)

11. X-RAY UNIT
    A. Manufacturer _____ Model _____
    B. Tube Serial Number _____
    C. Console Serial Number _____

12. TYPE OF UNIT
    1. Portable ____
    2. Fixed one tube ____
    3. Fixed two tubes ____
    4. Tilting table one tube ____
    5. Tilting table two tubes ____
    6. Upright fluoroscope ____

13. A. BEAM CENTERING DEVICE
    0. None ____
    1. Light ____
    2. Beam Defining Light ____
    3. Ruled Scale ____
    9. Other (specify) ____

    B. RADIATION WARNING
    0. None ____
    1. Control Panel Only ____
    2. Outside Room ____
    9. Other (specify) ____

    C. KV INDICATOR
    0. None ____
    1. Kilovolts ____
    2. Primary Volts ____
    3. Arbitrary Units ____
    9. Other (specify) ____

    D. MA INDICATOR
    0. None ____
    1. Arbitrary Units ____
    2. Milliamperes ____
    9. Other (specify) ____

14. TUBE HOUSING
    1. Diagnostic Type ____
    2. Non-Diagnostic Type ____
    3. Metal with shockproof leads ____
    4. Non-Metal (specify) ____

15. TIMER
    A. TYPE
    0. None ____
    1. Mechanical ____
    2. Electrical or Electronic ____

    B. TERMINATES EXPOSURE
    0. Yes ____
    1. No ____
    B. Unknown ____

    C. DEAD-MAN SWITCH
    0. Yes ____
    1. No ____

DIAGNOSTIC RADIOGRAPH SURVEY (Con.)

16. RADIOGRAPHIC CONES AVAILABLE

CONE NUMBER	CONE TYPE 36"	BEAM DIMENSION 72"

(Measure in increasing cone size)

17. PROTECTIVE DEVICES
1. Barrier for Operator _____
2. Lead-Equiv. Glass Window in Barrier _____
3. Audible Communication During Exposure _____
4. Protective Aprons & Gloves _____
5. Gonadal Shields _____

18. OPERATOR'S EXPOSURE ESTIMATE:

(Total No. Examinations) (all types) per week (_____Exams./week) X (Ave. Secs per) (examination) (___Sec/exam.) X (Operator's exp) (in mr/hr.) (___mr/hour) / (3600 sec/hour) = (Est. Oprs.) (exposure) (____mr/wk.)

PA CHEST	AP Lumbar Spine	Flat Plate Abdominal	Other Types Exams (spec'd)

19. FILTRATION:
Thickness of Filter Present in Unit _____mm. of Al. equivalent
FILTRATION: TARGET TO CHAMBER 20" DISTANCE, _____KVP, _____ma.

Sec. Time	Monitor R	Monitor R/S	CAP POSITION	Measurement R	Measurement R/S	cap-off/cap-on Ratio
			OFF			
			ON			
			OFF			
			ON			

20. TOTAL FILTRATION (of Primary Beam, in mm. of Al. Equiv.)
A. Before Modification _____

B. After Modification _____

Appendix 9 (Con.)

FLUOROSCOPIC SURVEY

Technique _____

IDENTIFICATION

21. Number of Examinations (per week) _____ Operator _____

22. Estimated Average Time per exam. _____ (in minutes)

23. Type of dark adaptation before fluoroscoping and time (in minutes)
    0. None_____ Red Goggles_____ Darkness_____ Light Leaks_____

24. Lead Aprons
    0. None_____ 1. Present but not in use_____ 2. Present and in use____

25. Lead Gloves
    0. None_____ 1. Present but not in use_____ 2. Present and in use____

26. Accessory Protective Devices
    0. None_____ 2. Leaded drapes around viewing screen_____
    1. Bucky slot cover_____ 3. Leaded chair_____
    4. Other (specify)_____

Physical Inspection

27. Radiation Warning Indicator Yes_____ No_____

28. Manually Reset Cumulative Timer Yes_____ No_____

29. Type of Fluoroscope
    1. Vertical_____ 2. Horizontal_____ 3. Tilting Table _____
    a. Manufacturer_____ b. Model_____
    c. Tube Serial number_____ d. Console Serial #_____

30. Is function of Shutters Adequate Yes_____ No_____

31. Normal Operating control settings KVP_____ MA_____

32. Primary beam limited to Fluoroscope screen
    (Screen 15" from table top) Yes_____ No_____

33. Target-to-panel distance (inches) _____

34. Transmission (in mr/hr) through screen and lead glass at reported operating conditions _____

35. Filtration of primary beam
FILTRATION: Target to Chamber _____ In. _____ KVP_____ MA

Minutes	Monitor R/Min.	CAP	Measurement R/Min	Ratio
		OFF		
		ON		
		OFF		
		ON		

Total Filtration_____

36. Roentgen output at panel surface (r/min)_____

37. Scattered Radiation Using Phantom and 4"x4" Field at Normal Operating Control Settings: a) scatter index
1. low reading in mr/hr_____ 2. high reading in mr/hr _____

COVER SHEET FOR SUPPLY OF PATIENT RECORD FORM

POLK COUNTY HEALTH DEPARTMENT - FLORIDA STATE BOARD OF HEALTH

Diagnostic X-ray Study

Introduction

There is a great need for information to provide reliable data in evaluating the extent of exposure to diagnostic x-rays. This is recognized internationally by well known organizations concerned with the health effects of ionizing radiation. This study is designed to obtain estimates of radiation exposure from diagnostic x-ray procedures in Polk County and to form a basis for consultation with the practitioner.

The study project is a joint endeavor of the Polk County Health Department and the Florida State Board of Health. It is financed in part by a contract with the U. S. Public Health Service. Further information or questions may be answered at our field office located at 495 North Hendry Avenue, Bartow, Florida, Telephone 533-7652.

E. G. Williams, M. D., Director
Division of Radiological
and Occupational Health
Florida State Board of Health

James Cason, M. D.
Director
Polk County Health Department

POLK COUNTY HEALTH DEPARTMENT - FLORIDA STATE BOARD OF HEALTH
DIAGNOSTIC X-RAY SURVEY

Page _____

GENERAL

CODE NO _____
PATIENT NO _____
DATE OF EXAM _____

PATIENT
AGE: ____ Yrs. at last Birthday
HEIGHT: ____ Ft. _____ Inches
WEIGHT: _____ Lbs.
RACE: _____ White _____ Non-White
RESIDENCE: _____ Polk County _____ Out of State
_____ Other County in Florida

SEX: _____ Male
Female { ___ Not Pregnant
___ Susp. Preg.
Trimester:
___ 1st ___ 2nd ___ 3rd

FLUOROSCOPY Unit No _____
TYPE OF EXAMINATION: (See List).....
PROJECTION: (AP,PA,Lat,Obl,etc.).....
TECHNIQUE:
KVP.....
ma.....
Minutes.....
FIELD SIZE:
Maximum __ in x in or __ cm x cm.....
Most Used.....
ANATOMICAL EMPHASIS.....
THICKNESS OF PART ___cm ___ in.....
NO. OF SPOT FILMS _____ KVP _____ ma _____ Average Exp.Time/Film _____ sec

RADIOGRAPHY Unit No _____
NAME OF EXAMINATIONS: (See List).....
PROJECTION: (AP,PA,Lat,Obl,etc.).....
TECHNIQUE:
KVP.....
ma.....
Sec.....
CONE (Number).....
TARGET - FILM DIST. ___cm___in.....
THICKNESS OF PART _____cm___in.....
FILM:
Size ___cm___in.....
Brand.....
Type.....
Grid.....
Screen.....

FORM S-2 (NYU P-2a)

Appendix 11

COVER LETTER FOR REPORT FORMS SENT TO MEDICAL X-RAY OPERATOR

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

_____, M. D.
864 Orangeland Avenue
Bartow, Florida

Dear Dr._____:

We wish to express our appreciation for your participation in the Radiation Protection Survey which was recently conducted by the Florida State Board of Health and the Polk County Health Department.

Accompanying this letter for your consideration are specific remarks on certain observations made at your installation. May we take this opportunity to offer our services in any manner that would render assistance to you.

Also enclosed for your convenience are copies of the following publications:

1. "A Practical Manual on the Medical and Dental Use of X-Rays with Control of Radiation Hazards", prepared by the American College of Radiology.

2. A graphic illustration of the value of limitation of beam size in radiography.

We intend to tabulate the countywide findings from this survey and plan to send you this information when it is complete.

Very truly yours,

Edgar F. Seagle
Radiological Engineer

For: E. G. Williams, M. D., Director
Division of Radiological
and Occupational Health
Florida State Board of Health

EFS:bc

Enclosures

_____
(Date of Survey)

FLUOROSCOPIC MACHINE:

Location _____

Room No. _____ Type of Unit _____

Console Serial No. _____

ITEM CHECKED	COMMENT	APPLICABLE SECTION OF HANDBOOK 76 (see attached sheets)
1. Dose rate at panel or table top at ___ KVP and ___ Ma.	____ r/min.	Sec. 6.1.h.
2. Distance, tube target to panel or table top (inches)	____ inches	Sec. 6.1.b.
3. Total filtration (mm. aluminum equivalence)	____ mm.	Sec. 6.1.d.
4. Goggles for dark adaptation readily available Explanation: See accompanying remarks.	Yes ___ No ___	None For explanation, see accompanying remarks.
5. Shutter mechanism functions freely:	Yes ___ No ___	None. For explanation, see accompanying remarks.
6. Shutter mechanism permits adequate variety of beam sizes:	Yes ___ No ___	Sec. 6.3.c(1) for further explanation, see accompanying remarks.
7. Shutter mechanism satisfactory for preventing primary beam from "spilling-over" the fluorescent screen	Yes ___ No ___	Sec. 6.1.e.(2)
8. Satisfactory time-limiting device	Yes ___ No ___	Sec. 6.1.g.
9. Lead gloves and aprons readily available for use to protect personnel:	Yes ___ No ___	Sec. 6.3.d. 6.3.e. 6.1.i.

FLUOROSCOPIC MACHINE, Continued:

ITEM CHECKED	COMMENT	APPLICABLE SECTION OF HANDBOOK 76: (See attached sheets)
10. If lead gloves and aprons present, integrity of leaded material satisfactory:	Yes ___ No ___	None. For explanation, see accompanying remarks.
11. Transmission of X-Ray beam through lead glass probably within satisfactory limits, _____ mr/hr.	Yes ___ No. ___	Sec. 6. 1. e. (1) For further explanation, see accompanying remarks.
12. Adequate protection against scattered radiation from scattered radiation based on 100 mr/week limits	Yes ___ No ___	Sec. 4. 2. b., page 8 Table 1, Page 22, Sec. 5. 6. a., Page 10
13. Adequate protection against scattered radiation from scattered radiation, based upon 25 mr/week limit:	Yes ___ No. ___	Sec. 5. 6. a, page 10 Sec. 5. 6. d, page 10
14. Adequate devices to prevent leakage of light into the fluoroscopic examining rooms	Yes ___ No ___	Sec.6. 1. k, page 12
15. Remarks, or other comments: (attach additional sheet if necessary)	Yes ___ No ___	None

_____

_____

_____

_____

GENERAL COMMENTS ABOUT RADIATION SAFETY AND MEDICAL FLUOROSCOPIC MACHINES

Criteria used in considering the safety aspects of medical fluoroscopic machines are taken from recommendations of the National Committee on Radiation Protection and Measurements as contained in National Bureau of Standards Handbook 76 (Handbook 76), issued Feb. 9, 1961. This 52-page booklet is available from the Superintendent of Documents, Washington 25, D. C., - price 25 cents. Certain elaborations are taken from "A Practical Manual on the Medical and Dental Use of X-Rays with Control of Radiation Hazards", a 30-page publication prepared by and available at 25 cents from the American College of Radiology, 20 N. Wacker Drive, Chicago, Illinois.

The philosophy prompting recommendations contained in Handbook 76 as stated in the Preface, page V, is: "That unnecessary radiation exposure should always be avoided and all exposure held to the minimum compatible with practical clinical requirements." Practical methods for achieving such a reduction in exposure of radiation to both patient and operator are suggested in the Manual of the American College of Radiology. More especially is it urged that every operator familiarize himself with the safety rules and with the sections of Handbook 76, as is suggested on page 9, paragraph 5.3 of that publication.

The entirety of Section 6 of Handbook 76 should be reviewed by those concerned with the use of a fluoroscope. There are many notable points covered in Handbook 76 which are not touched upon by this survey. Specific safety aspects included in the survey are referenced in Handbook 76. The following are included:

1. PANEL EXPOSURE DOSE RATE:

Section 6.1.h, page 12: "For routine fluoroscopy, the exposure rate measured at the panel or table top should be as low as possible and shall not exceed 10 r/min."

2. TARGET-TO-PANEL DISTANCE:

Section 6.1.b., page 11: "The target-to-panel or target-to-table top distance should not be less than 18 in., and shall not be less than 12 in."

3. TOTAL FILTRATION:

Section 6.1.d, page 11: "The total filtration permanently in the useful beam shall not be less than 2.5-mm aluminum equivalent."

4. APPARATUS FOR DARK ADAPTATION:

Ready availability of equipment for dark adaptation is desirable to insure consistent use. Patient dose is directly related to dark adaptation time, such time improving vision up to 20 minutes, according to the Practical Manual by the American College of Radiology, page 20.

COMMENTS ON FLUOROSCOPIC MACHINES, Cont'd:

5, 6, & 7. ADEQUATE SHUTTER OPERATION:

Ease-of-operation of field reducing shutters is important in assessing function. Section 6.3.c.(1) suggests that when field reducing shutters are available to give an adequate variety of beam sizes, the patient exposure is reduced accordingly. Section 6.1.e(2) states that collimators shall be provided to restrict the size of the useful beam to less than the area of the viewing device, the x-ray beam shall not spill over the viewing screen. If shutters do not function with ease, such adequate variety of sizes is not necessarily assured all of the time.

8. TIME LIMITING DEVICE:

Section 6.1.g., page 12: "A manually reset, cumulative timing device shall be used which will either indicate elapsed time by an audible signal or turn off the apparatus when the total exposure exceeds a predetermined limit in one or a series of exposures. The device should have a maximum range of five minutes."

9. 10. PROTECTIVE APRONS AND GLOVES:

Section 6.3.d, and Section 6.3.e, page 13: "Unless measurements indicate otherwise protective aprons of at least a quarter millimeter lead equivalent should be worn by all persons in the fluoroscopic room, except the patient. Protective gloves of at least a quarter millimeter lead equivalent should be worn by the fluoroscopist during every examination."

11. SCREEN TRANSMISSION:

Section 6.1.e, page 12: "The equipment shall be so constructed that the entire cross section of the useful beam is attenuated by a primary barrier. This barrier is usually the viewing device, either a conventional fluoroscopic screen or some sort of image intensification mechanism. This may be constituted by the lead glass of conventional fluoroscopic screens."

EXPLANATION: Some authorities feel that if proper barriers do exist for beam attenuation, the dose rate will not exceed the range of 20 to 50 mr/hr at screen surface under the most adverse operating conditions possible. Reference is made to the maximum permissible dose of 100 mr/week as the average weekly dose, as expressed in Handbook 76, Table 1, page 22. Dose rates exceeding 20 mr/hr indicate the inadequacy of the viewing device if the work load is much over five hours per week.

12. EXCESSIVE SCATTER TO OPERATOR:

Sec. 4.2.b, page 8: "... If, at any of the indicated positions, any person is likely to be exposed to more than the maximum permissible dose (as expressed in Handbook 76, Table 1, page 22), then recommendations of changes to eliminate the radiation hazard shall be made, with due regard to actual operating conditions..." Personnel monitoring is suggested in Handbook 76, Sec. 5.6.a, page 10 such as film badge service, for individuals likely to receive more than 25 mr/week, which is one fourth of the maximum permissible dose of 100 mr/week.

COMMENTS ON FLUOROSCOPIC MACHINES, Cont'd:

13. PERSONNEL MONITORING:

Sec. 5.6.d, page 10: If personnel monitoring devices are used and more than 25 mr/week doses are indicated as being received, inadequacies of operating conditions are likely to exist.

14. REDUCTION OF LIGHT INTENSITY IN FLUOROSCOPIC EXAMINING ROOM:

Sec. 6.1.k, page 12: "Attention should be given to reducing light intensity in the room." This would imply that there be no leakage of light into the room.

15. REMARKS, OR OTHER COMMENTS:

This survey does not intend to cover detailed requirements. However, any outstanding comment may be added. Specify "none" if no remarks.

RADIOGRAPHIC MACHINE:

Location _____

Room No. _____ Tube Housing Serial No. _____

Type of Machine _____

Facilities for chest x-ray exposures: Yes _____ No _____

X-Ray beam dimensions at plane of film (chest radiography): _____
(Refer to explanation under Beam Size)

Total Filtration (mm. of aluminum equivalent): _____
(Refer to Filtration)

Protective barrier at operator's position: Yes _____ No _____
(Refer to Operator Protection)

Beam Centering Device: Yes _____ No _____

Recommendations:

Remarks:

General Comments About Radiation Safety Aspects of the Use of Radiographic Machines

The more recent recommendations of the National Committee on Radiation Protection and Measurements regarding radiation safety were published in February 1961 in the 52-page National Bureau of Standards Handbook 76, "Medical X-Ray Protection Up to Three Million Volts." Copies are available from the Superintendent of Documents, Washington 25, D. C. - price 25 cents.

A good many recommendations were made in Handbook 76 regarding radiation safety, including the need for adequate protective barriers in the walls, etc. (see pages 5-7), the need for protection surveys and inspections (pages 7-9), and the need for instruction of personnel in safe operating procedures (page 9, paragraph 5. 2). Paragraph 5. 3 of Handbook 76 indicates: "Every operator should be familiar with the safety rules and with the sections of this Handbook applicable to his work and should be guided by the recommendations."

Among the specific recommendations in Section 7 of Handbook 76 dealing with medical radiographic installations are the following:

Beam Size:

Section 7. 3. c(1) (page 15): "The radiographic field should not be larger than is clinically necessary. The radiologist should enforce proper collimation, providing either an adequate assortment of cones or an adjustable collimation with beam-defining light."

Explanation: Many authorities feel that for radiographic exposures made onto 14" x 17" film, the ideal size for the x-ray beam at the plane of the film would be a 14" x 17" rectangular beam. In order to just encompass a 14" x 17" film with a circular x-ray beam, one with a diameter of 22" would be needed. Some authorities believe that in any case, the diameter of a circular beam used to expose a 14" x 17" film should not exceed 24" at the plane of the film. In chest radiography, for example, as the size of the circular beam increases beyond 22" diameter, there is a greater chance that the ovaries or testes of patients will be included in the primary beam. When the beam exceeds 33 inches in diameter for chest radiography, the almost certain inclusion of the reproductive cells in the primary beam has been found to cause an increase in the ovarian dose (or the dose to an unborn child in the case of a pregnant woman) by almost 100 times; the testicular dose would be increased by 400-500 times. Of course, the use of adequate lead protection over the lower trunk of individuals having chest x-ray examinations would tend to reduce to a considerable extent the gonadal dose of individual patients in these cases where large x-ray beams are used. Restriction of the size of the beam to the area of interest, however,

has been considered to be preferable. (See "Measurement of Bone Marrow and Gonadal Dose From the Chest X-Ray Examination as a Function of Field Size, Field Alignment, Tube Kilovoltage, and Added Filtration" - by E. R. Epp, A. Weiss, and J. S. Laughlin, British Journal of Radiology, February 1961).

Filtration:

Section 7.1.c (page 14): "The total filtration permanently in the useful beam shall not be less than 2.5 millimeters of aluminum equivalent..."

Operator Protection:

Section 7.1.e: "A dead-man....switch shall be provided and so arranged that it cannot be conveniently operated outside a shielded area....."

Section 7.2.c (1): "The operator's station at the control shall be behind a protective barrier, either in a separate room, in a protected booth, or behind a fixed shield which will intercept the useful beam and any radiation that has been scattered only once..."

Operating Procedures:

Section 7.3.a: "No person occupationally exposed to radiation shall be permitted to hold patients during exposures, nor shall any person be regularly used for this service."

Section 7.3.b.: "Only persons required for the radiographic procedure shall be in the radiographic room during exposure. All such persons, except the patient, should wear protective aprons and gloves unless measurements indicate that these are not required. No parts of the bodies of these persons shall be in the useful beam."

Section 7.3.c. (2): "The gonads of children and persons who have not passed the reproductive age should be protected from the useful beam by the use of careful field collimation or special gonad shields when this will not impair the value of the examination."

PHYSICAL RADIATION PROTECTION SURVEY OF DENTAL X-RAY EQUIPMENT INSTALLATION CARD NO. 1

2. STATE, COUNTY, CITY (1 2 3 4 5 6 7 8)

3. DENTIST, CARD IDENTIFICATION (9 10 11 12 13 14 15)

1.
- A. _____ NAME OF USER(S)
- B. _____ INSTALLATION ADDRESS
- C. _____ PHONE NUMBER
- D. _____ CITY
- E. _____ COUNTY
- F. _____ STATE
- G. _____ NAME OF SURVEYOR

4. TOTAL X-RAY UNITS AT INSTALLATION (16)

5. X-RAY UNIT IDENTIFICATION NUMBER (17)

6. NUMBER OF PERSONS OPERATING THIS UNIT (18)

7. NUMBER OF OFFICE PERSONNEL
- A. FULL TIME DENTISTS (19)
- B. PART TIME DENTISTS (20)
- C. OTHER FULL TIME PERSONNEL (21)
- D. OTHER PART TIME PERSONNEL (22)

8. TYPE OF PRACTICE (23)
1. GENERAL ____
2. ORAL SURGERY ____
3. ORTHODONTIC ____
4. PEDODONTIC ____
5. PERIODONTIC ____
6. PROSTHODONTIC ____
7. MORE THAN ONE TYPE ____
9. OTHER (SPECIFY) _____

9. X-RAY UNIT
- A. MANUFACTURER _____ MODEL _____ (24 25)
- B. TUBE SERIAL NUMBER _____ (26 27 28 29 30 31 32 33 34)
- C. CONSOLE SERIAL NUMBER _____ (35 36 37 38 39 40 41 42)

10. POINTER CONE (43)
0. NONE ____
1. SHORT POINTED ____
2. SHORT OPEN ____
3. LONG POINTED ____
4. LONG OPEN ____
9. OTHER (SPECIFY) ____

11. FIELD DIAMETER AT END OF POINTER CONE (inches)
- A. BEFORE MODIFICATION _____ (44 45 46)
- B. AFTER MODIFICATION _____ (47 48 49)

12. TOTAL FILTRATION OF PRIMARY BEAM (mm Al equiv.)
- A. BEFORE MODIFICATION _____ (50 51 52)
- B. AFTER MODIFICATION _____ (53 54 55)

13. ROENTGEN OUTPUT AT END OF POINTER CONE IN r/sec.
- A. BEFORE MODIFICATION _____ (56 57 58)
- B. AFTER MODIFICATION _____ (59 60 61)

14. IS X-RAY UNIT OPERABLE AT LEAST 6 FEET FROM TUBE HEAD (62)
0. NO ____
1. YES ____

15. TIME (63 64)
SURVEY BEGAN _____ SURVEY ENDED _____ DIFFERENCE IN MINUTES

16. DATE OF SURVEY (65 66 67 68)
(MONTH/DAY/YEAR) _____

17. FURTHER CONSULTATION RECOMMENDED (69)
0. NO ____
1. YES (SEE REMARKS) ____

18. CODE NUMBER OF SURVEYOR (70 71)

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Rev 5-61

Form Approved
Budget Bureau No. 68-R733

CARD NO. 2 | IDENTIFICATION (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17)

19. TIMER

A. TYPE — 0. NONE ____ 1. MECHANICAL ____ 2. ELECTRICAL OR ELECTRONIC ____ (18)

B. TERMINATES EXPOSURE — 0. NO ____ 1. YES ____ 2. UNKNOWN ____ (19)

C. STOPWATCH CHECK — TIMER SETTING ____ STOPWATCH READING ____ DIFFERENCE (20)

20. X-RAY UNIT GROUNDED — 0. NO ____ 1. YES ____ 2. UNKNOWN ____ (21)

21. STABILITY OF TUBE HEAD — 0. ADEQUATE ____ 1. NOT ADEQUATE ____ (22)

22. TUBE HOUSING RADIATION LEAKAGE WITHIN RECOMMENDED STANDARDS — 0. NO ____ 1. YES ____ (23)

23. PROTECTIVE BARRIERS — 0. NONE ____ 1. FIXED WITH LEAD WINDOW ____ 2. FIXED WITH NO LEAD WINDOW ____ 3. MOBILE WITH LEAD WINDOW ____ 4. MOBILE WITH NO LEAD WINDOW ____ 5. PRESENT BUT NOT IN USE ____ 9. OTHER (SPECIFY) ____ (24)

24. LEAD APRONS — 0. NONE ____ 1. OPERATOR ONLY ____ 2. PATIENT ONLY ____ 3. BOTH OPERATOR AND PATIENT ____ 4. PATIENT BUT NOT IN USE ____ (25)

25. PERSONNEL MONITORING

A. TYPE — 0. NONE ____ 1. FILM BADGE ____ 2. POCKET CHAMBER ____ 3. POCKET DOSIMETER ____ 4. DENTAL FILM ____ 9. OTHER (SPECIFY) ____ (26)

B. TIME — 0. NONE ____ 1. CURRENTLY BEING USED ____ 2. WAS USED WITHIN THE PAST 12 MOS ____ 3. WAS USED OVER ONE YEAR AGO ____ (27)

C. RESULTS — 0. NONE ____ 1. [illegible] ____ 2. BELOW 25 mr/wk ____ 3. 25 TO 100 mr/wk ____ 4. ABOVE 100 mr/wk ____ (28)

26. WORKLOAD

A. ESTIMATED NUMBER OF FILMS PER WEEK ON THIS UNIT ____ (29 30 31)

B. AVERAGE EXPOSURE TIME PER FILM OF UPPER FIRST MOLAR ____ (32 33 34)

C. CALCULATED AVERAGE EXPOSURE TIME PER FILM (in seconds) ____ (35 36 37)

(AVG. EXP. = UP. MOLAR X .7)

D. USUAL MILLIAMPERES ____ (38 39)

E. MILLIAMPERE-SECONDS PER WEEK ____ (40 41 42 43)

F. USUAL KILOVOLTAGE ____ (44 45)

27. FILM USED

A. BITEWING — MANUFACTURER ____ TYPE OR CODE ____ (46 47)

B. PERIAPICAL — MANUFACTURER ____ TYPE OR CODE ____ (48 49)

LIST OTHER FILMS USED REGULARLY

28. DARKROOM PROCEDURES

A. DEVELOPER USED — MANUFACTURER ____ TYPE ____ (50 51)

B. USUAL DEVELOPMENT TIME (in minutes) ____ (52 53)

C. USUAL TEMPERATURE OF DEVELOPER (in degrees fahrenheit) ____ (54 55)

D. THERMOMETER IN DARKROOM — 0. NO ____ 1. YES ____ 2. THERMOSTATIC CONTROL ____ 3. NO DARKROOM ____ (56)

E. USUAL CHANGE OF DEVELOPER (in weeks) ____ (57 58)

F. IS DARKROOM LIGHT TIGHT — 0. NO ____ 1. YES ____ (59)

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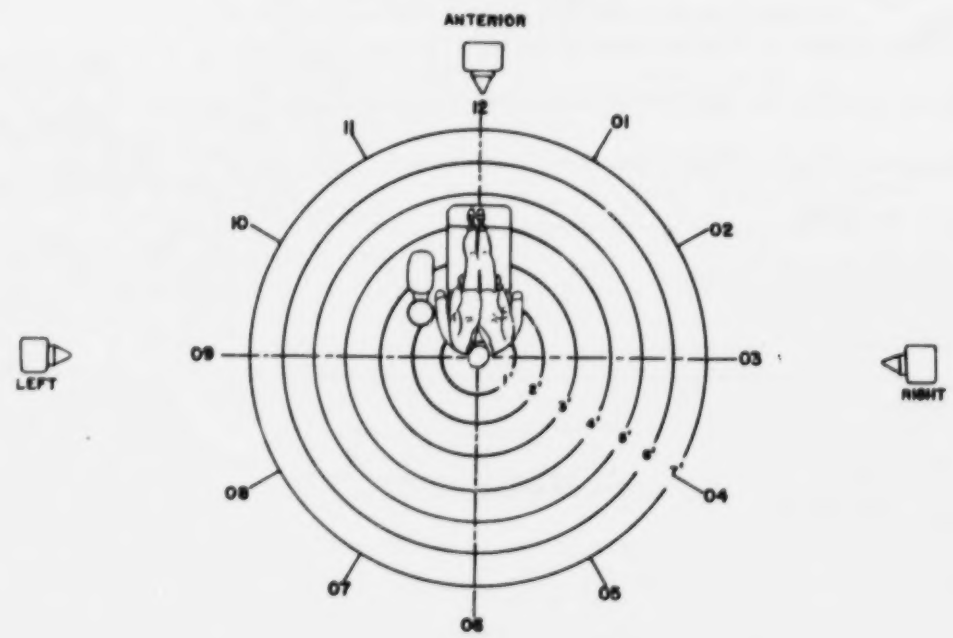
CARD NO. 3	IDENTIFICATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

29. OCCUPATIONAL EXPOSURE; SCATTER RADIATION (REFER TO DIAGRAM BELOW).

	AT NORMAL OPERATING POSITION				AT NEW POSITION
	DIRECTION	DISTANCE	mr/hr		mr/hr
I LEFT BITEWING EXPOSURE					
A. DENTIST	18 19	20	21 22 23 24		25 26 27
B. ASSISTANT	28 29	30	31 32 33 34		35 36 37
II ANTERIOR UPPER PERIAPICAL EXPOSURE					
C. DENTIST	38 39	40	41 42 43 44		45 46 47
D. ASSISTANT	48 49	50	51 52 53 54		55 56 57
III RIGHT BITEWING EXPOSURE					
E. DENTIST	58 59	60	61 62 63 64		65 66 67
F. ASSISTANT	68 69	70	71 72 73 74		75 76 77



30.

TYPE OF SURVEY INSTRUMENT USED _____ 78

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NOTE: TIME SURVEY ENDED

CARD NO. 4	IDENTIFICATION	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

3I. BEAM QUALITY DETERMINATION (CAP ON/CAP OFF METHOD)

A. KVP FOR THIS EXPOSURE _____ 18 19

B. MA FOR THIS EXPOSURE _____ 20 21

C. CHAMBER A CAP OFF
TIME IN SECONDS _____ NUMBER OF ROENTGENS _____ ROENTGENS/SEC 22 23 24

D. CHAMBER B CAP OFF
TIME IN SECONDS _____ NUMBER OF ROENTGENS _____ ROENTGENS/SEC 25 26 27

E. CHAMBER A CAP ON
TIME IN SECONDS _____ NUMBER OF ROENTGENS _____ ROENTGENS/SEC 28 29 30

F. CHAMBER B CAP OFF
TIME IN SECONDS _____ NUMBER OF ROENTGENS _____ ROENTGENS/SEC 31 32 33

G. RATIO CAP ON / CAP OFF — CHAMBER A _____ 34 35 36

H. HALF VALUE LAYER CALCULATED _____ 37 38 39

I. TOTAL ALUMINUM EQUIVALENT FILTRATION _____ 40 41 42

3I. REMARKS

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POLK COUNTY HEALTH DEPARTMENT - FLORIDA STATE BOARD OF HEALTH
DIAGNOSTIC X-RAY SURVEY
DENTAL

GENERAL

Page _____
CODE NO. _____
PATIENT NO. _____
DATE OF EXAM. _____

PATIENT

AGE: _____Yrs. at last birthday
HEIGHT: ____Ft. ____Inches
WEIGHT: ____Lbs.
RACE: _____White_____Non-White
RESIDENCE: _____Polk County_____Out of State
_____Other County in Florida

SEX: _____ Male _____Female
(_____ Not Pregnant
(_____ Susp. Preg.
(Trimester:
(____ 1st ___ 2nd ___3rd

Use One Column for Each Exposure

RADIOGRAPHY

Name of Examination: (Bitewing, Periapical, etc.).....				
Projection: (Right, Left, Anterior Upper, Etc.).....				
Technique: KVP.....				
MA.....				
SEC.....				
Cone: Long or Short.....				
Open or Pointed.....				
Film: Size.....				
Manufacturer.....				
Type.....				

Continued

Exam.....									
Proj.....									
KVP.....									
MA.....									
SEC.....									
CONE.....									
Film Size....									
Mfg.....									
Type.....									

Continued

Exam.....									
Proj.....									
KVP.....									
MA.....									
SEC.....									
CONE.....									
Film Size....									
Mfg.....									
Type.....									

Form S-3 DENTAL

COVER LETTER FOR REPORT FORM SENT TO DENTAL X-RAY OPERATOR

FLORIDA STATE BOARD OF HEALTH
Division of Radiological
and Occupational Health
495 N. Hendry Avenue
Tele. 533-7652

_____, D.D.S.
1906 Apple Lane
Sunnydale, Florida

Dear Dr._____:

We wish to express our appreciation for your participation in the Radiation Protection Survey which was recently conducted by the Florida State Board of Health and the Polk County Health Department.

Accompanying this letter for your consideration are specific remarks on certain observations made at your installation. May we take this opportunity to offer our services in any manner that would render assistance to you.

Also enclosed for your convenience is a copy of the following publication:

"Radiation Protection for Dentist and Patient", prepared by the Division of Radiological Health of the U. S. Public Health Service.

We intend to tabulate the countywide findings from this survey and plan to send you this information when it is complete.

Very truly yours,

Edgar F. Seagle
Radiological Engineer

For: E. G. Williams, M. D., Director
Division of Radiological and
Occupational Health
Florida State Board of Health

EFS:bc

Enclosures

Appendix 14 (Con.)

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL AND OCCUPATIONAL HEALTH

DENTAL X-RAY UNIT INSPECTION

Date _____

Location _____

Manufacturer _____ Model _____

Tube Serial No. _____ Console Serial No. _____

ITEM	Present at Time of Visit	Corrected To	Satisfactory
1- Total Filtration of Primary Beam (including inherent)	_____	_____	Yes ___ No ___
2- X-ray beam diameter at end of Pointer Cone	_____	_____	Yes ___ No ___
3- Stability of Tube Head			Yes ___ No ___
4- Tube housing radiation leakage within recommended limits			Yes ___ No ___
5- Unit operable at least 6 feet from tube head or otherwise compensated for			Yes ___ No ___
6- Exposure Timer Adequate			Yes ___ No ___
7- Dead man type exposure switch			Yes ___ No ___

Recommendations:

Remarks:

THANK-YOU LETTER TO RECORD KEEPERS

FLORIDA STATE BOARD OF HEALTH
DIVISION OF RADIOLOGICAL
AND OCCUPATIONAL HEALTH
495 N. HENDRY AVENUE
BARTOW, FLORIDA

Mrs. _____, X-Ray Technician
Popular Memorial Hospital
Bartow, Florida

Dear Mrs. _____:

The Staff of the Polk County Health Department and the Florida State Board of Health X-Ray Study thanks you for your cooperation in the data collection phase of its work. Without your diligent help, a study of this nature would be impossible. The enclosed check is in appreciation of your sincere effort.

Sincerely,

Edgar F. Seagle

EFS:bc

Enclosure

X-Ray Installation Re-Check Form

Polk County Health Department - Florida State Board of Health Diagnostic X-Ray Study

Practitioner _____ Date _____
Installation Address _____
County _____
City and State _____ Person Interviewed _____

Question: Have you had an opportunity to make any of the changes recommended in our report?

Yes _____ No _____

If answer is Yes:

(1) Re-survey the unit(s) in light of the change(s) made and record the reduction in exposure by virtue of these changes. Use back of original survey form.

(2) If only part of the changes have been made, when will the others be complete? _____

(3) Why were all changes not made?

If answer is No:

(1) Why were changes not yet made?

(2) When will changes be made?

Questions to be answered whether changes have or have not been made:

(1) Were the recommendations clearly understood?

(2) Was a service man readily available?

(3) Did you feel the recommendations were practical and necessary as well as conforming with National Bureau of Standards Handbook 76 and the Florida State Sanitary Code?

(5) Did the record keeping, which was designed to aid our research part of the study, have any beneficial effect to you or your staff, i. e., incidental to its primary purpose?

(6) What could we do to assist you the most in making the changes we recommend?

(7) In your estimation, is this x-ray survey a worthwhile program?

(8) Would you have preferred that we telephoned before coming for a re-check or come unannounced or does it make any difference?

Remarks:

THE ABSTRACT CARDS accompanying this report are designed to facilitate information retrieval. They provide space for an accession number (to be filled in by the user), suggested key words, bibliographic information, and an abstract. The key word concept of reference material filing is readily adaptable to a variety of filing systems ranging from manual-visual to electronic data processing. The cards are furnished in triplicate to allow for flexibility in their use.

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